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WONDERS OF LAND AND SEA

Painted under the direction of Arthur Holmes, F.G.S. by John R Gauld

The Birth of Our Planet

The earth began as a nebular knot, surrounded on every side by streams of meteoric matter. By the force of gravity the latter were slowly aggregated into clusters, and these in turn were drawn in by the earth until our planet finally attained its present size

WONDERS OF LAND AND SEA

EDITED BY

GRAEME WILLIAMS, F.R.G.S.

Fellow of the Royal Historical, the Geological and the Zoological Societies

With an Introduction by

SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

And Contributions by Many other Eminent Specialists

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New and Revised Edition

WONDERS OF LAND AND SEA

Editor's Preface

APART from the separate issues in various foreign languages, this work has been reprinted many times since the volumes were first published in 1914, but, beyond the removal of errata, no alterations have been made until the present edition, which has been substantially revised.

I gladly take this opportunity to acknowledge my thanks to all those—particularly members of the teaching profession—who have in various ways contributed to make "Wonders of Land and Sea" so widely known and so remarkably successful. Readers of all classes have written to me from every part of the world; many letters with valuable suggestions which will not be lost sight of in future productions. Several correspondents declared that a really interesting work, as well illustrated as "Wonders of Land and Sea," but dealing with the geography of the world, was very much needed; this proposal has been acted upon, and the publishers have now produced, under the same editorship, a four-volume illustrated description of the lands and seas of the globe, their peoples, animals, plants, and products, entitled "The World We Live In," to which Professor Grenville Cole, Mr. Arthur Hinks, Sir Harry Johnston, Mr. W. H. Koebel, Professor Lionel W. Lyde, and other well-known authorities have contributed.

In issuing the present edition of "Wonders of Land and Sea" I have found it necessary to displace entirely a few short articles in order to make room for further material, and to revise others in order to bring them up to date. In some cases, owing to the Great War, this has been done without consultation with the original writer, in which case the latter's name has been removed from the head of the article, and the Editor alone is responsible for statements of fact.

As to the object of this work, I cannot do better than repeat what I said in the preface to the first edition:—

Emancipation of Intellect

So far from super-civilisation having dulled the appetite of modern man for that which is marvellous, the emancipation of intellect, during the last century, has opened up for us a thousand new paths for the exercise of curiosity which were barred to our forefathers. A generation or two ago, when it was considered impious to doubt that our earth was only some 6,000 years of age, and fossil and other indications to the contrary were declared to be devices of the Evil One for the confounding of religion, the whole series of marvels which geology reveals were a closed book to most of us. Now, however, the geologist can calculate the age of our planet in hundreds of millions of years without incurring censure. The same remark applies to the discoveries of Darwin and other mighty intellects; at first denounced as impious by the worthiest people of their time, they are now accepted almost as commonplaces.

Craving for Information

Great as has been the advance of civilisation in other directions during the last fifty years, it is doubtful whether anything has happened of half so great importance to the human race as this freeing of thought from artificial and arbitrary trammels. As the first fruit of it we see, newly born on the part of the great masses of intelligent people, a hunger for wider knowledge concerning the natural phenomena of earth, and sea, and sky, coupled with an interest in all kinds of human achievement.

This craving for information shows that there is room for a work written by specialists, which takes for its field both natural wonders and the marvellous works of man on land, in the air, and on sea, in which the "marvellous" or "curious" element owes nothing to perversion of fact.

In the present work, no effort has been spared to secure contributors who are specialists in their own fields of knowledge, and whose names alone are a sufficient guarantee of the pains which each has taken to verify every statement made in the articles to which his name is attached.

In order to secure an interesting variety, with due representation of different fields of interest, the work has been roughly sectionalised. The word "roughly" is used advisedly, since it would be impossible to do this thoroughly without the use of scores of subdivisions. Reducing these to a bare minimum, five main headings have been adopted, as shown in the following table:—

SECTION
I. ON THE LAND.
II. IN THE UNDERWORLD.
III. ON THE SEA.
IV. IN THE DEPTHS.
V. MAN AND PROGRESS.

Classification

Each of these main headings again has been broadly divided into two subsections, (*a*) Natural and (*b*) Artificial. It may sometimes happen that a subject will be dealt with in one or other of these sections which the critic might prefer to place in another, or which, logically, it might be difficult to assign to either. The scheme is, frankly, a compromise between over-minute classification on the one hand, and entire absence of it on the other—both very confusing. Each main heading is carried serially forward at intervals of from forty to fifty pages. With the aid of the index no difficulty will be experienced in locating any item.

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AND OTHER LEADING SPECIALISTS

Photo: Lafayette Studio, Perth, W.A.

West Australian Native Prisoners

The Australian native is among the most primitive of present-day human types

Links of Creation

Introductory Essay on the Fossil and Living Forms which Link Up Present-day Mammals, Birds, Reptiles and Fish with their Prehistoric Ancestors

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

I.—MAMMALS

THE revelation of the fossil remains of animals in river, sea, and lake deposits, gravels, sands, slates, and rocks, has achieved much in enabling us to realise not only the enormous diversity in animal as in vegetable life since living forms of matter came into existence on this planet, but to accept the theory that all forms of life have gradually descended, through variation and differentiation, from one original and simple form of living matter.

It is wonderful that it should have taken Man so long to realise the meaning of fossil remains. The full force of this evidence was practically not taken into account until a hundred years ago, since which time our knowledge of "the world that was" has increased at an amazing ratio. So that now we no longer look upon the various orders or genera of animals as isolated examples of creative caprice or wisdom, but simply as the outstanding results of long ages of experiment on the part of Nature, each order being or having been connected with other orders by intermediate types which at one time completely bridged over the differences between a greater and a lesser degree of evolution. Thus we know, or we can presume by parallel argument, that no living genus of animal or plant has come

Photo: Umlauff, Hamburg

A Gorilla Photographed after Being Shot

Amongst mammals, the anthropoid apes (the gibbon, siamang, orang, chimpanzi, and gorilla), which are nearer to man in structure than they are to the monkeys, give suggestions as to stages in the evolution of the human genus

suddenly into existence, but that it is only due to the segregated results of a long series of specific modifications.

Nature, no doubt, did not always progress in her work at the same rate. Species *may* have sprung suddenly into existence as "sports," or varieties, and have hardened rapidly in a few generations into immutable species. Evolution, variation from the parent form, progresses more rapidly in some epochs and under some physical conditions than in other times and tempers. We see this in the development of human tribes and races, and in domestic animals. A human tribe suddenly finds itself in better circumstances. It increases, multiplies, improves at a much faster rate than that taken by its predecessors, who for long had struggled to maintain themselves under unfavourable conditions.

The past history of the evolution of mammals (for example) is suggested not only by the discovery of "links of creation" in the soil or the rock, but in the life history of each living individual before the animal becomes adult.

Thus the young of most toothless mammals, either in their fœtal stage or for a short time after birth, reveal the existence of undeveloped teeth, which afterwards become absorbed or hidden by a growth of gum, and are completely absent in the adult.

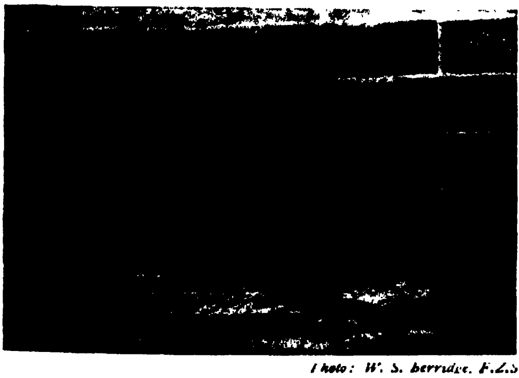


Photo: W. S. Berridge, F.Z.S.

The Fossa

rous mammal which, perhaps, from the Eocene period of the Tertiary Epoch

W. S. Berridge, F.Z.S.

Ring-tailed Lemur

The Lemurs represent the Eocene stage in Man's ascent

But the ancient relationships between orders and families now widely sundered in specialisation, are indicated, in addition to the evidence of fossil and fœtus, by the existence at the present day of anomalous creatures which remain isolated in type, and yet suggestive of affinities in many directions; so that they are really sign-posts pointing out the routes taken by many diverging descendants of ancestral genera.

Amongst mammals, for example, we have the Anthropoid Apes (described elsewhere in this work) which give us broad hints—not as yet perfectly understood—as to the ancestry of man; we have the Lemurs of Madagascar, Africa, and Southern Asia, suggesting a still earlier stage in Man's ascent, when an arboreal creature, using its long-fingered hands for grasping, and preferring to walk on its hind legs, was emerging from a still earlier stock, almost akin to the Marsupials—generalised forms which in themselves united the germ of the Ungulate or hoofed mammals, the Insectivores, and the Edentates. The flying Colugo or *Galeopithecus*, of Malaysia is another link of creation of extreme interest to the biologist. This creature, the size (in its different types) more or less of a cat, has slight affinities with the Lemurs, others with the Bats, and a relationship with the Insectivores. If it be not an actual surviving indication of the way in which bats grew out of a Lemuroid or Insectivore stock, it is, at any rate, a parallel illustration of their line of evolution, though I think myself that the ancestral Bat made much more use of its hands than is the case with the Colugo, and that its enormously long-fingered hands (like those of the Aye-aye Lemur of Madagascar) gradually became webbed and united with the parachute-like membrane developed by so many mammals that do not fly by flapping, like the modern bat, but glide through the air.

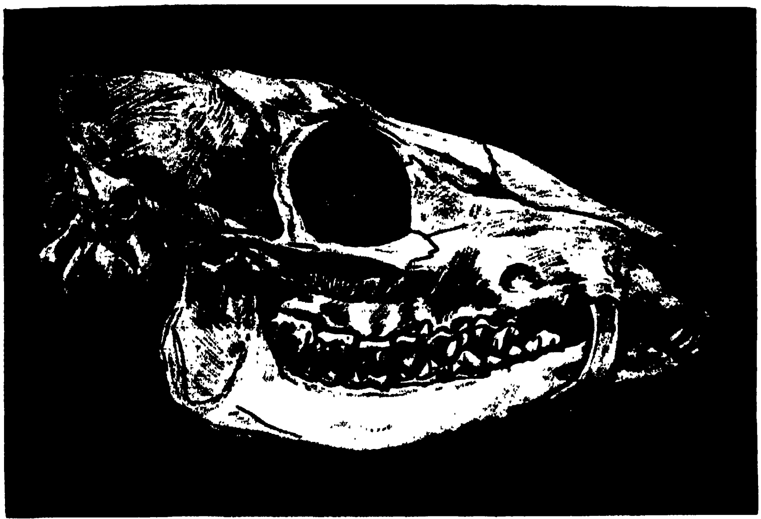
In Madagascar, the home of so many lost causes and poor relations, whose cousins have achieved their destiny elsewhere, we have the Fossa, a fierce carnivorous mammal, which perhaps survives from a most remote period at the beginning of the Tertiary Epoch, when the specialised Cats were beginning to emerge from the dog-civet-weasel type of carnivore. The modern Fossa is about the size of a pointer dog, but an extinct type in Madagascar grew to be as large as a puma.

In Central Asia there is the *Æluropus*, or large, short-tailed Panda, which, though it is not a direct ancestor of the Bears,

Photo: Henry Irving

A Link between the Pigs and the Bovines

The *Dorcatherium*, or Water Chevrotain of West Africa



By permission of Sir H. H. Johnston

Skull of the *Dorcatherium*

is very suggestive of the way in which the Bear group rose from some similar Raccoon-like creature; just as the Bush Dog of Guiana (*Icticyon*) is reminiscent in some aspects of the ancestral dogs. The Hyraxes of Africa and Syria give us a general idea of the outward aspect of the primeval Ungulate, a type of creature not far off the early Lemurs, which developed in the course of ages into the astounding forms of Elephant and Arsinotherium, Dinoceras, Rhinoceros, and Horse, Camel, Hippopotamus, and Ox.

But one of the most interesting of living links is perhaps the *Dorcatherium* or Water Chevrotain of West Africa. Without much difficulty, we can trace the Hippopotamuses, Pigs, and Camels from the earliest even-toed Ungulates (that great group which, instead of going in for a central toe, adopted an equal division of toes, and finally became two-toed instead of one-toed). But a great gap still remains to be filled between the Pigs and the Deer, or the Pigs and the Bovines (oxen, antelopes, etc.). This gap is bridged almost half-way by the existing *Dorcatherium* and its more specialised allies, the little *Traguli* of India and Ceylon. The *Dorcatherium* has, like the Pig, four complete toes on each foot (instead of only two toes and uncertain vestiges, as in the ruminating mammals). The *Dorcatherium* has canine teeth in both jaws, and other features in its anatomy which indicate an affinity with the Pigs as well as with the Ruminants. It retains in its coloration the white spots and stripes which we believe to have been the original possession of all primitive Ungulate animals, and which subsist elsewhere in the Tapir, in horses and zebras, in the Deer and the Tragelaphs, as well as in certain rodents, the aforementioned Colugo, the Bear-like carnivores, and numerous Marsupials.

Photo: Henry Irving

Front Leg of *Dorcatherium*

Scale of Geological Systems

Figs. indicate max. known thickness

PLEISTOCENE (4,000 ft.)

PLIOCENE
(13,000 ft.)
At least 3 million years

MIOCENE
(14,000 ft.)
At least 7 million years

OLIGOCENE
(12,000 ft.)

EOCENE
(20,000 ft.)
At least 31 million years

CRETACEOUS
(44,000 ft.)

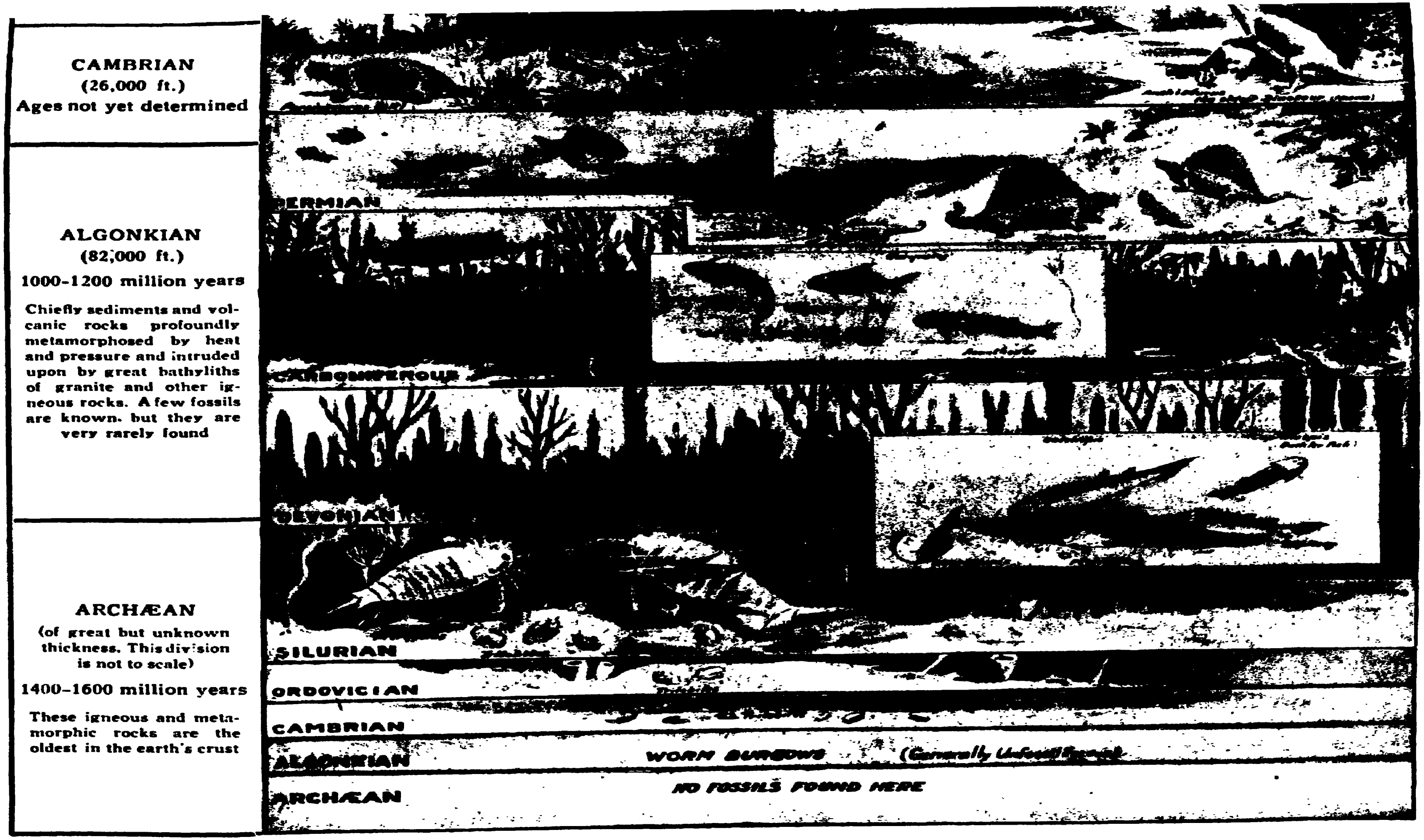
JURASSIC
(8,000 ft.)

TRIASSIC
(17,000 ft.)

PERMIAN
(12,000 ft.)

CARBONIFEROUS
(29,000 ft.)
340 million years

DEVONIAN
(22,000 ft.)
370 million years



CAMBRIAN
(26,000 ft.)
Ages not yet determined

ALGONKIAN
(82,000 ft.)
1000-1200 million years

Chiefly sediments and volcanic rocks profoundly metamorphosed by heat and pressure and intruded upon by great bathyliths of granite and other igneous rocks. A few fossils are known, but they are very rarely found

ARCHÆAN
(of great but unknown thickness. This division is not to scale)
1400-1600 million years

These igneous and metamorphic rocks are the oldest in the earth's crust

THE RECORD OF THE ROCKS

In the above diagram the scale on the left (kindly arranged by Mr. Arthur Holmes, F.G.S., A.R.C.S., of the Geology Section, Imperial College of Science), indicates the maximum known thicknesses of the various geological strata. The right-hand portion graphically illustrates the forms of life existing at each geological period, as proved by fossil remains, and enables one to grasp the theory that all forms of life have gradually descended, through variation and differentiation, from one original and simple form of living matter

Introduction

The Pygmy Hippopotamus of Liberia illustrates a phase in the earlier history of this even-toed Ungulate when it was less aquatic, longer-legged, and with a smaller head—a little nearer to the pig-like ancestors. The Tapirs of America and Asia are remarkable survivors from the early Miocene, and bring before our eyes the beginnings of the rhinoceros and horse groups. And, lastly, we have not only the Marsupials to show us the type of earliest Eocene or even Cretaceous mammal, which dwelt in England some five to seven million years ago, but even the Platypus of Australia and the Echidna of New Guinea, *egg-laying* mammals, like those of Triassic and Jurassic days, almost reptilian in their affinities with the Bird-reptiles, the Anomodonts which arose at the close of the Primary Epoch.

Photo: W. S. Berridge, F.Z.S.

An Egg-laying Mammal, the Platypus

II.—BIRDS

We are dealing only with existing and visible links of creation in this Introduction, therefore I shall not do more than mention in passing that invaluable fossil link in the evolution of birds from reptiles, the Archæopteryx, the remains of which are found in Southern Germany, and have enabled us to understand to some extent the lines on which birds developed from a purely reptilian ancestor.

From such scanty palæontological evidence as we possess, we must imagine birds, as we now know them, to have been in existence at the close of the Secondary Epoch, and well established in their existing families, and even genera, at the commencement of the Tertiary. During that long Eocene period (on which greater and greater demands of time are being made by biologists in order to account for the amazing evolution of flowering plants, insects, mammals, and birds which took place between the close of the Cretaceous period and the beginning of the Miocene) birds were probably extremely abundant all over the earth, and the orders and families which are now so separate, distinct, and even isolated, were linked up by countless intermediate forms.

A few of these have remained down to the present day. There is the Ostrich, for example. This flightless bird, like its fellow Ratites (so called from their flattened, raft-like breastbone), has specialised in many directions, yet retains several archaic features in its anatomy and outward aspect. For instance, young ostriches, like the other young Struthiform birds, have the lizard-like markings—longitudinal stripes of dark and light—down the head and neck and dimly discernible on the body plumage. These markings are also characteristic of the young of many birds living on the ground or in the water—all that vast cohort of struthious, tinamine, gallinaceous, and gralline birds—Plovers, Gulls, Auks, Rails, Cranes, Bustards, and Ducks.

The young of the Ostrich, till they moult into their first stage of mature plumage, have on the back a curious type of feather, the lower half of which is little else than a flattened, pointed scale, one amongst other indications showing us that birds in their evolution developed from spiny, scuted, porcupine-like reptiles. The Tinamus — also with bristly plumage in the young—are links between the Ostrich group and the Game Birds and Rails. They inhabit South America, that special home of peculiar, isolated birds. The Penguins are very isolated, as also are the Petrels, the Divers and Grebes, though there may be an ancient relationship between all these three groups.

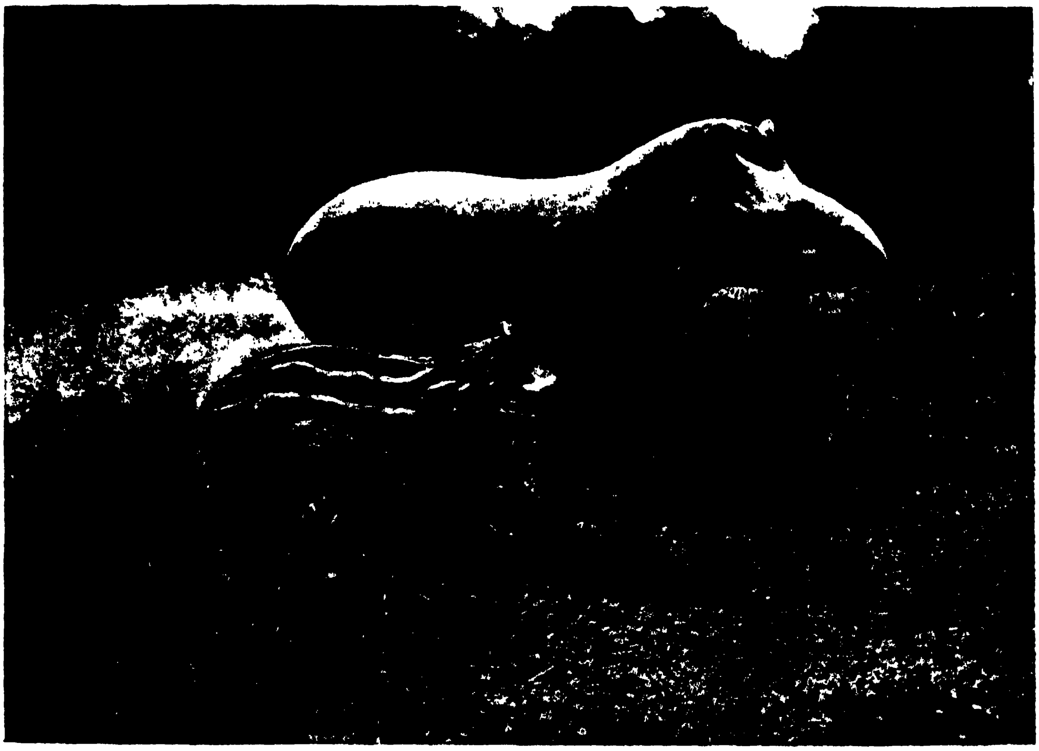


Photo by permission of the New York Zoological Society

American Tapirs—Survivors from the Early Miocene

The Penguins retain one interesting archaism in their structure. What is called the metatarsus (the part of the human foot bones between the toes and the ankle joint) is unlike that of any other bird, in that it is very short in proportion to the rest of the limb bones, and instead of being fused into a single bone, as it is in all other birds (with only slight indentations indicating that it was once composed of three—originally five—bones), it is imperfectly fused; so that three distinct elements are clearly traceable.

A most interesting living link is the family of the Horned Screamers of South America (*Palamedeidæ*). This is a group of rather big birds with fairly long, stout legs and very large feet. They seem to be the modified descendants of a parent group of generalised wading-birds, equally ready (as are their descendants at the present day) for land or water, a group from which sprang the Tinamus, the Gallinaceous birds, the Cranes, the Rails, the Plovers, Pigeons, and Gulls, the Bustards, and above all the Flamingoes, Ducks, and Geese. The Seriema of South America and the Secretary Bird of Tropical Africa are suggestions as to how the great group of birds of prey—the Vultures, Hawks, and Eagles—may have arisen from crane-like ancestors, quite possibly in that equatorial continent which united Africa and India with South America.

The Tufted Umbre of Africa (*Scopus*), together with some forms of Ibis, the Sun-bittern of South America and the Kagu of New Caledonia, indicate to some degree the appearance of the parent forms of the Stork and Heron families at a time when they were evolving from crane-like or plover-like birds, just as the curious Seed-snipe (*Thinocorys* and *Attagis*) of South America suggest links between the fowl- and pigeon-like birds and the plovers, the Sheath-bills (*Chionidiæ*), the intermediate form between plovers and gulls, and the Sand-grouse of the Old World deserts and the Hemipodes (*Turnicidæ*), stages in the evolution of Pigeons and Plovers.

As it is, birds at the present day can be more or less roughly divided into two great sections: the birds of the trees and the birds of land and water. The former are small as compared to the latter, their feet are usually much better developed for perching, and amongst the Passerine birds the foot with its four well-developed toes is probably nearer that of the reptile ancestor than amongst the otherwise more archaic ground birds. Between these two great groups, each bound together by certain loose affinities, there is very little in the way of living links. Such as there are consist of two remarkable families—the Turacos or Plantain-eaters (described on page 196 *et seq.*), and the Hoatsin of northern South America (*Opisthocomus*). The Hoatsin, which is about the size of a pheasant, is so constructed internally and externally that authorities on ornithology are for the most part undecided as to whether its affinities lie more with the Rails and Gallinaceous birds than with the Cuckoos and Turacos. It even suggests in its life habits, its ineffective flight and general appearance, faint resemblances to the extinct Archæopteryx, and no doubt is descended very little altered from a primitive type of True Bird not far from the common stock out of which all True Birds branched off.

In the vast cohort of tree-frequenting birds there are many indefinite forms which to some extent link up one order and family with another. The Turacos themselves in some measure serve as links between the isolated Parrots and the Cuckoo group. Madagascar, like South America, is a great place for indeterminate forms in beasts, birds, and reptiles. It contains the Ground-rollers, which, like the *Eurylæmidæ* or Broad-mouths of South-eastern Asia, are very nearly in the position of links between the Passerine birds on the one hand and the Roller-like birds on the other. These last—the *Coraciiformes*—include the Rollers, Kingfishers, Bee-eaters, Hornbills, and Hoopoes, the Owls and the Goat-suckers (between which are the curious link-like forms, the Oil Bird, ***Steatornis***, of South America, and the ***Podargi*** or Frog-mouths of Australasia), the Swifts and Humming Birds, the Colies, the Trogons, Barbets, and Woodpeckers. The Passerine birds are bewildering in their diversity, yet with some exceptions have a great similarity in structure. As we know, they are nearly all small birds, only developing to any degree of size in the Hornbills, the Eagle-owls, the Ravens, and the Lyre Bird of Australia. This last, though it is a true Passerine bird, is nevertheless an extremely interesting link of creation, since it indicates probably the appearance of some of the ancestral Passerine birds at a time when they were less divergent from the land and water group. The strong legs and well-developed toes and terrestrial habits of the Lyre Bird, even if they are a return to former conditions, are nevertheless a feature which gives the bird the appearance of an intermediate form.

Yet in attempting to map out the evolution of birds, we must always bear in mind the fact that their very possession of wings and many other peculiarities in their con-

Links of Creation

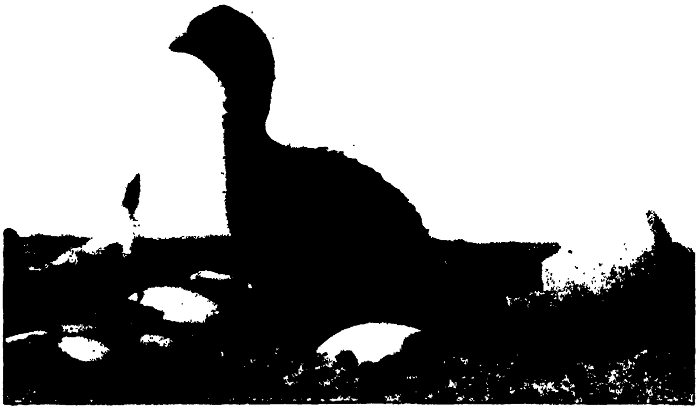


Photo taken in Herr Hagenbeck's Tierpark

A Newly-hatched Ostrich

Observe the lizard-like markings down the head and neck. Note also the curious type of feather, one amongst other indications showing that birds in their evolution developed from spiny, scuted, porcupine-like reptiles

struction, show that they must have had a considerable acquaintance with Tree life in developing from reptilian ancestors before they became sufficiently well established in the world to give rise to such purely terrestrial forms as the Ostrich or such completely aquatic animals as the Penguin.

III.—REPTILES

The reptile class has suffered sorely at the hands of Time. The few descendants of this once world-dominating type of vertebrate, if they had the intelligence of human beings, might, with a sigh of consolation, note the splendid development and prosperity of their bird and mammal offshoots, but could only regard their own position at the present day as one of not-long-deferred extinction. There are tremendous gaps between the existing Reptilian orders, greater than any that occur between the divisions of birds and mammals.

Present day reptiles may be classed in the following groups: there are the *Rhyncocephali* — represented by that most remarkable of all surviving links, the *Sphenodon* or Tuatera of New Zealand; the *Chelonia* or Tortoises; the Crocodiles; and the Lizards and Snakes, which last form a sub-class distinct from the three other sub-classes. The Tuatera "lizard" of New Zealand is, without a doubt, the most remarkable living link in creation existing at the present day; and the New Zealand Government should sit in penance once a year till further notice for its shameful neglect of this scientifically important animal. When New Zealand was first explored by Captain Cook, the Tuatera was

Photo taken in Herr Hagenbeck's Tierpark

Penguins—an isolated group of Birds

probably still fairly abundant in the North Island, though it had already been brought low in numbers during the several centuries of colonisation by the Polynesian Maoris. For the Tuatera was no doubt eatable, especially by savages not over particular in their tastes.

But the advent of British settlers in the nineteenth century soon brought this most interesting of all living vertebrates near to the point of extinction. The new colonists set fire to the bush, clubbed the Tuatera to death (on the principle of "larning a twoad to be a twoad"), and allowed it to be destroyed by dogs and pigs. With the result that the sole survivors of *Sphenodon punctatus* are restricted in their range to a few islets in the Bay of Plenty at the north end of the North Island of New Zealand. The Dominion of New Zealand, when it was granted that proud title and condition of independence, as a great country of the future, should have taken as its emblem the most interesting creature to be found within its territorial limits. The Tuatera is a direct descendant of the oldest and most primitive group of reptiles —the *Prosauria*—whose genealogy can be traced back to the Permian period of the Primary Epoch. Creatures similar to the Tuatera were living in England and Scotland, as well as in Germany, France, and India, at the end of the Primary Epoch, tens of millions of years ago. From the group of which the Sphenodon is the sole survivor there arose, in the course of these ages, all the great developments of the Reptiles—the Beast-like reptiles (which died out after they had produced the mammalia), the terrific Dinosaurs, who, in humbler developments may have been the ancestors of the Birds, the great Sea-reptiles, and the Pterodactyls or Flying-reptiles; besides the ancestors of the Tortoises, Crocodiles, Mososaurs, Lizards and Snakes.

The Sphenodon is perhaps the only "link of creation" especially to be singled out amongst the reptiles at the present day, because between the other great groups—Tortoises and Crocodiles and True Saurians (Lizards and Snakes), there are no living links. The Saurian group of lizards and snakes, which are descended from creatures not unlike the Sphenodon, are the latest developed forms of reptiles, and are accurately subdivided into two orders—the Lizards and the Snakes; while the lizards again are somewhat sharply divisible into three groups—the Geckos or Wall-lizards, the True Lizards, and the Chameleons. There is no living link between any of these three families, though there are instances of accidental resemblances, the most remarkable being the *Lyriocephalus* of Ceylon, which, though it is a true Agamid Lizard, bears a remarkable superficial resemblance to the Chameleons. Neither, perhaps, can it be said that there are any living links between the Lizards and the Snakes, though there are several developments in the Lizard sub-order, such as the familiar Blind-worm, or the *Amphisbæna*, and the *Pygopodi* (of Australia) which are almost—and sometimes quite—limbless, and imitate a stage in the similar evolution of the Snake from the Lizard. And there are some snakes, like members of the Python family and of the burrowing snakes, which have distinct vestiges of hind limbs, and in the construction of their jaws show a slighter degree of affinity with the lizards than the rest of the *Ophidia*.

IV.—FISH

As has so often happened in the history of evolution, the fish in their comparatively early stages, when they had developed from still more primitive vertebrates, like the Lampreys and the Amphioxus, gave off branches of seemingly little importance at the time, which were to lead to far higher and more wonderful developments; while concurrently the main impulse of the fish creation was to take a very different direction and to perfect itself for the occupation of deep waters, especially of the ocean.

Links of Creation

By far the greater number of fish species at the present day are actually included within the limits of a single order—the *Teleostei*, of the sub-class *Teleostomi* (from two Greek words meaning "completely bony," in contrast with the more archaic fish which are more cartilaginous or not so elaborately developed in their bony skeleton and skull). This order includes, as I shall relate in my articles on the Sargasso Sea, nearly eleven and a half thousand out of the twelve thousand species of existing fish, the remaining five hundred or so species being allotted to the more primitive orders of the Ganoids, the Sturgeons, and Paddle-fish, the Bow-fins and bony Garpike; and to the sub-classes of the Sharks and Chimæras, and of the Lung-fishes. These Modern Fish, of the order *Teleostei*, only make their first appearance in the geological record in the early part of the Secondary Epoch; not until the close of that epoch did they predominate in the seas of the ancient world as they do to-day.

Photo: W. S. Berridge, F.Z.S.

The Tuatera (*Sphenodon*), the Most Remarkable Surviving Link of Creation

From the *Prosauria* group (existing tens of millions of years ago), of which the *Sphenodon* is the sole survivor, there arose the terrific *Dinosaurs*, as well as the ancestors of the tortoises, crocodiles, lizards, and snakes

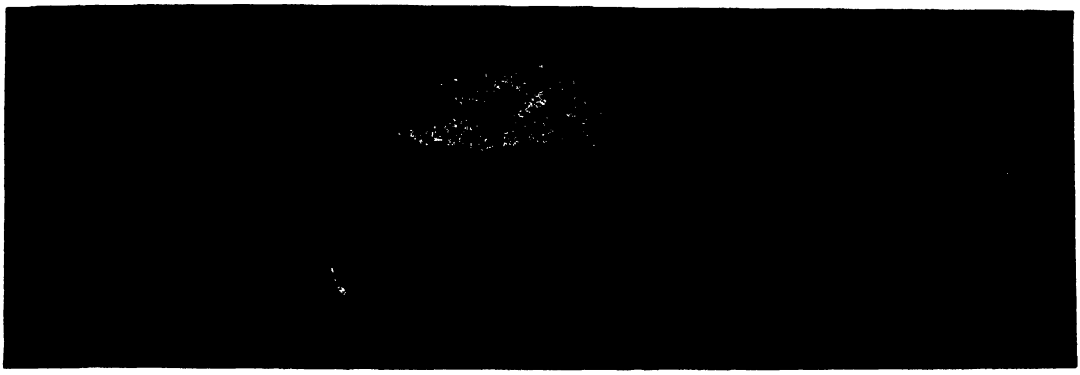
In discussing the fauna of the Sargasso Sea, I allude to the arrangement of the limbs in modern Teleostean fish, and point out that even though in some cases appendages like arms and legs or long-fingered hands were developed (so that certain Teleostean fish actually walk over the surface of the ground), yet that these limbs and this method of progression were not on the same lines as those which had been developed in the land vertebrates. Therefore, in spite of the superficial resemblance offered by certain modern "Fish out of Water' to Amphibians, the likeness is only illusory, and is derived from later impulses of that recurring desire to leave the water, breathe the air, and take to a land life, which has repeatedly shown itself in the history of creation.

Living matter was, in all probability, developed in moisture, and grew into complicated organisms in shallow water. Comparatively few forms have sunk down to live in the depths of the ocean, but the bulk of water creatures frequent the surface or comparatively shallow depths; and again and again one class of beings after another, though originating in the water, has developed descendants which have become completely adapted to a land life, and even others which have proceeded to the conquest of the air.

Yet, though such an overwhelming preponderance of Modern Fish belong to one specialised type—represented by Tarpons, Electric Eels and Arapaimas, Herrings and Salmon, Carp and Barbel, Eels and Pike, Pipe-fish and Anglers, Perch and Mackerel, Cod and Sea-bream, Tunny and Flat-fish, Gobies, Gurnards, and Sunfish—there still remain in existence strange and often scarce fish whose affinities lie rather with long extinct forms of the Secondary and Primary Epochs: forms which in some ways indicate creatures less divergent than Modern Fish from the types of the far remote periods of the Primary Epoch, when the Amphibian was evolved from the fish and took to a life definitely associated with the land. Of such archaic fish are the Dipnoi or lung-fishes of Australia, Africa, and South America. These are very specialised and peculiar in their teeth; but in the arrangement and structure of their limbs—more especially in the *Neoceratodus* of North-eastern Australia—they make a slight approximation to the Amphibian. So that they are not unlike a certain stage in fish development which ended in the evolution of the Salamander-like Amphibians. The Lung-fishes have developed the air-bladder (found in so many fish) into a double lung, but they also retain gills to some extent. These fishes in the main, however, are dependent on access to atmospheric air (as, indeed, are a great many more Teleostean fish than is commonly supposed). They rise at intervals and protrude their snouts in order to empty the lungs of their used-up air, and to take in fresh supplies. The African and American forms of this group are able, in the dry season of the year, to live or hibernate in mud burrows, breathing at that time nothing but atmospheric air. But the *Neoceratodus* of Australia, though it may exist in partly dried-up water-holes in which the water has become thick and almost putrid, cannot live completely out of water, even though it may depend on the air more than on the water for its supply of oxygen.

Other types of fish which may be styled living links of creation, are the Ganoids, survivors of almost innumerable forms that existed in past ages. These living links, like the Lung-fishes, are almost entirely restricted in their range to fresh water—rivers and lakes—though the Sturgeons frequent the seas along the coast as well as the estuaries of rivers. The most interesting of the families of modern Ganoids is that which includes the Polypterid fishes of Tropical Africa. These present the long lizard-like form, and the wide separation between the fore-limbs and hind-limbs, which we may ascribe to the ancestral Amphibian. The air-bladder is double and is an accessory organ for breathing, supplementary to the gills.

The Sharks and Chimæras of the very distinct sub-class *Elasmobranchii*, are so far links of creation in that, by the arrangement of their two-paired limbs (especially in extinct forms, such as the remarkable *Pleuracanthus*), they suggest resemblances to the ancestral type of the Amphibians. The Lampreys again and the Hag-fishes (*Myxine*)—which are not properly speaking fishes at all, but quite a separate class—are in a sense representative of the connecting links between the Sharks and the True Fish on the one hand, and the headless Lancelet (*Amphioxus*) on the other; and the *Amphioxus* again gives us some idea of how the sub-kingdom of the Vertebrates arose (through the Ascidians and the Hemichordata) from the Worms.



Chaos. By G. F. Watts, R.A.
(From the Picture in the Tate Gallery)

The Birth of Our Planet

By ARTHUR HOLMES, F.G.S., A.R.C.S.

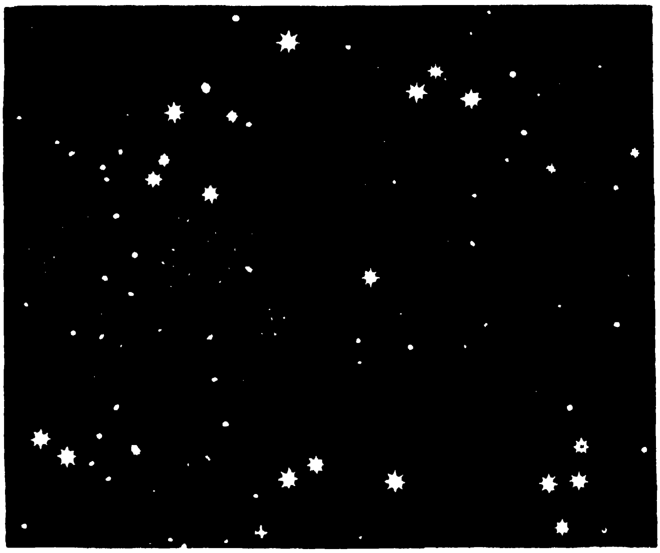
Author of "The Age of the Earth"

IN unravelling the story of the earth as it is revealed in the rocks, no principle has been of more permanent value than that which seeks to find in the geographical conditions of the present the key with which to unlock the secrets of the past. Thus, encouraged by its conspicuous success in the domain of geology, we may apply the same method to the more ambitious task of solving the problem of the earth's origin. But here the earth itself fails to provide us with any helpful clues, for as far back in time as the rocks can take us—over 1,500 million years—no definite signs of a beginning are met with. We must therefore look to the cosmic drama which is for ever being played upon the infinite stage of the heavens if we would find a parallel to the celestial event in which our planet took birth.

Suns, no less than men, are subject to the prevailing laws of birth and death, and among the thousands of millions of stars which penetrate the darkness of space, every phase of the life-history of a world is exemplified. Let us then look into the laboratory of the Universe and witness one of the colossal experiments by which Nature illustrates the genesis of a solar system.

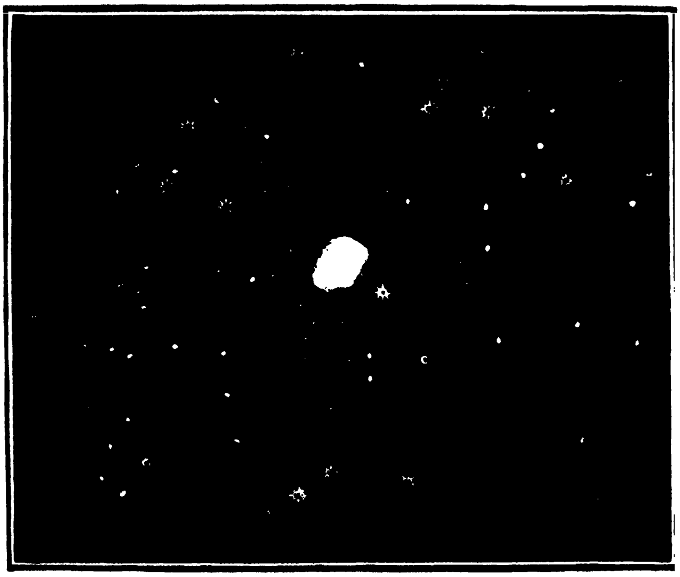
The little polar constellation of Perseus has always been of interest because of the curious behaviour of Algol, a twin star which regularly winks its eye once every sixty-nine hours, and was for that reason known to the Arabs as the Demon. However, Perseus made a still higher bid for fame early in 1901, for in the neighbourhood of Algol there suddenly appeared, as though to herald the dawn of the century, a wonderful new star. With amazing rapidity it soon outrivalled the brilliance of its twinkling neighbour and became the brightest object of the northern sky.

It was evident that a stellar catastrophe of the first magnitude had taken place. No less momentous an event than the collision or close approach of two celestial bodies was denoted by the furious flood of light and heat which the advent of a blazing star implied. It was calculated that the actual impact had probably occurred early in the reign of James I., but at such an inconceivable distance from the earth that the news of its occurrence, flashed across the ether of space by light waves travelling at over eleven million miles per minute, had taken three centuries to reach us.



Before the Catastrophe

Showing the normal appearance of the sky before the birth of the "New Star of the New Century"

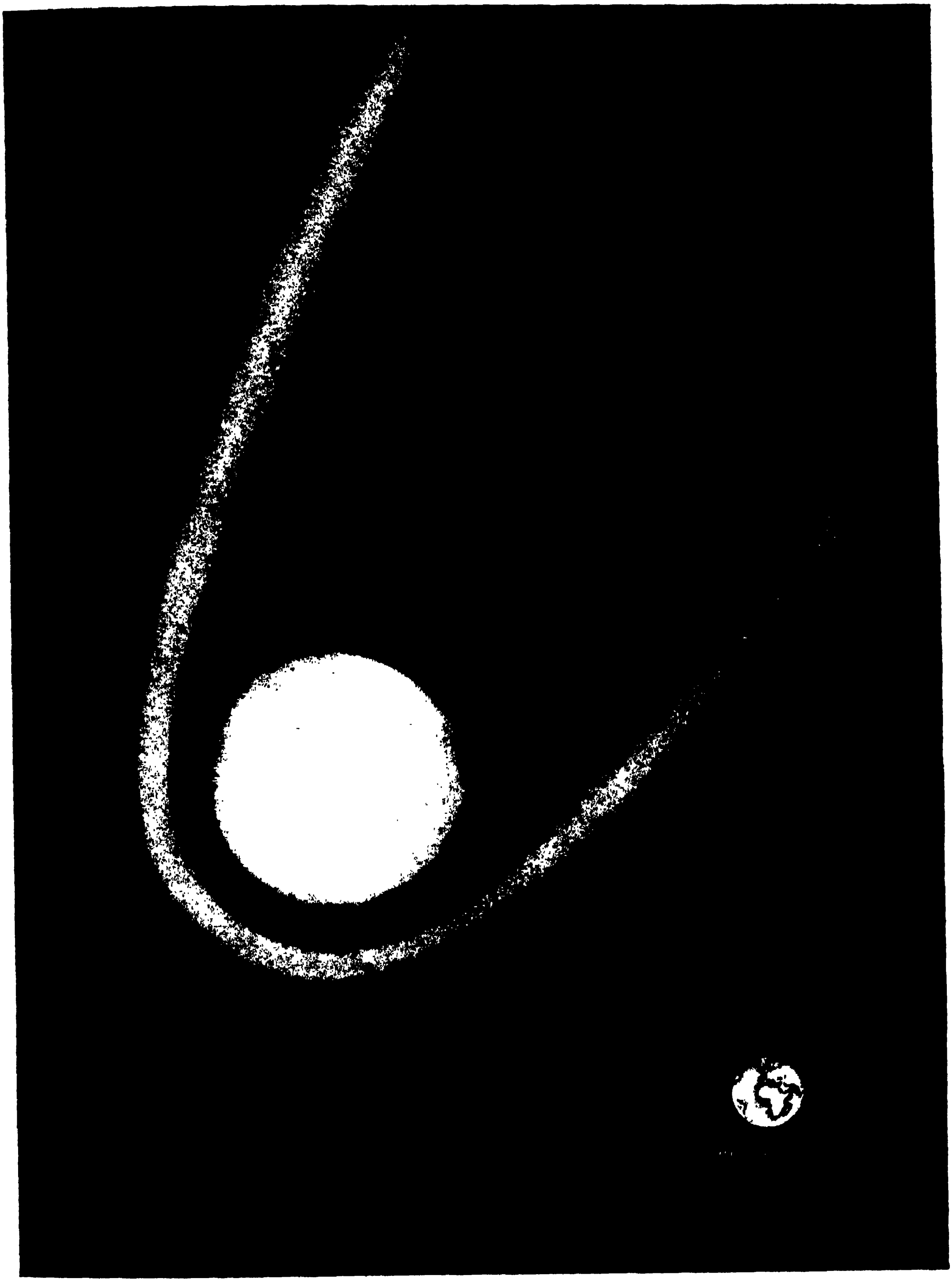


After the Catastrophe

No less momentous an event than the collision or close approach of two celestial bodies was denoted by the furious flood of light and heat which the advent of a blazing star implied

By the autumn of 1901 the new star had faded away into insignificance, but with the aid of telescope and camera the most astonishing feature of the whole occurrence was brought to light. It was noticed that the star was spinning about itself a fine web of nebulous wisps of matter. When photographs which had been taken earlier in its career were carefully examined, it became apparent that the first outburst of the conflagration was accompanied by the emergence of two spiral arms which issued from opposite sides of the star and gradually encircled it. The uncoiling of these misty streaks of light was followed with intense interest for several months until, towards the close of the year, the whole apparition died away into invisibility.

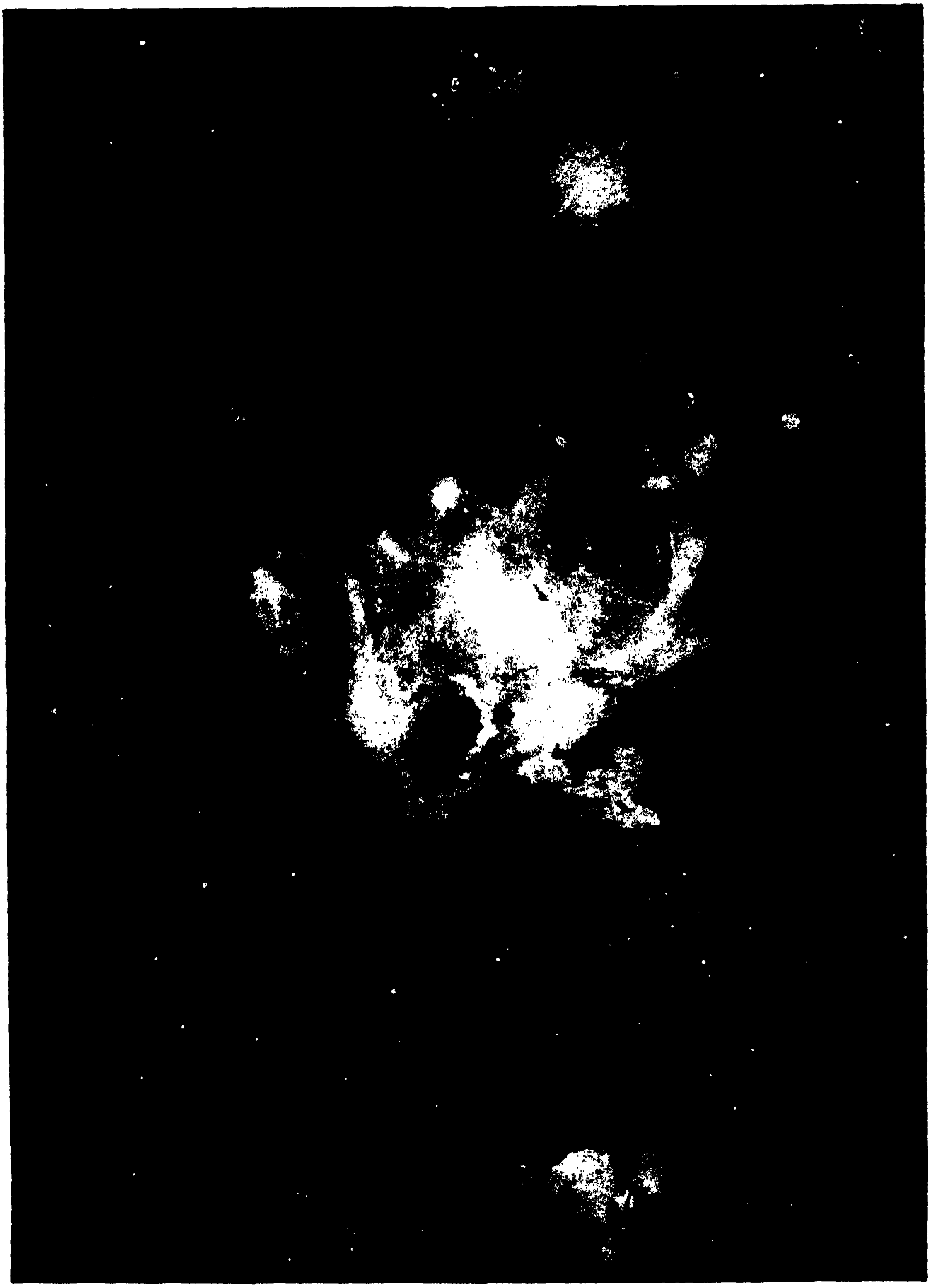
In some catastrophe such as this, the raw material of our earth became separated from the sun. But as the earth is merely one of the lesser children of the sun, it is impossible to consider the circumstances of its birth without dealing also with that of the whole solar family. The sun controls not a haphazard collection of unrelated bodies, but an orderly system bearing in the simplicity of its architecture the hall-mark of a common origin. So striking is the uniformity of movement and distribution of sun, planets and satellites, that the conclusion is irresistible that all were once



A Wanderer in Space

(Drawn by Scriven Bolton, F.R.A.S.)

" Comets are as numerous in space as fish are in the ocean. They travel in all directions, and we know not when or where a new one may appear. It is possible that our comparatively tiny earth one day collide squarely with the head of one of these visitants, although the chances are against such a happening," says Mr. Scriven Bolton



Photograph taken at the Yerkes Observatory, U.S.A.

The Birth of a Universe—in the Great Nebula of Orion

The Great Nebula of Orion is composed of incandescent matter rotating with incredible swiftness. As it cools its density increases, and it throws off portions which will be the making of new solar systems. In the Nebula of Orion we can see at work the processes which brought our own solar system into existence

united as a single body, and so closely does this assumption approach to certainty that the odds against a more fortuitous origin are billions of billions to one.

The genius of Laplace wrought this conception into the celebrated Nebular Hypothesis, a great mathematical poem of creation which profoundly influenced scientific thought throughout the nineteenth century. Laplace imagined that the ancestral body consisted of an immense gaseous nebula of lens-like shape extending outwards into space beyond the limits of the remotest planet. Dispersed through such a prodigious volume, the solar system would form a tenuous mist of rarefied matter resembling nothing so much as a vacuum, and compared with which the air we breathe would be 250 million times more dense. From the condensation of this nebula, Laplace tried to show how a sun with a circling family of planetary children and satellitic grandchildren might be developed.

We need not follow this majestic process in further detail, for insuperable difficulties have arisen at every stage, and so formidable are the discrepancies between theory and fact, that the hypothesis has now been reluctantly abandoned. One of the many objections is that no certain case of a nebula of the Laplacian type has ever been discovered, whereas innumerable examples of spiral nebulæ are known to exist.

The first spiral was revealed by Lord Rosse's giant telescope so recently as 1848, but since then, the heavens have been diligently explored again and again, and far from being the rarest it is found that the spiral structure is the most universal. Drawn out in graceful curves from opposite sides of a central nucleus, a pair of nebulous streamers can generally be seen, the precursors no doubt of a system of stars similar in its distribution to the solar family, but on an inconceivably vaster scale. Indeed stellar nuclei are often apparent in the delicate spirals of mist,

Photo by F. Hollyer

The Ordering of Chaos

(Painted by Sir E.

An artist's conception of the birth of our planet for here and there faintly luminous knots and irregularities break through. Spiral nebulæ may be appropriately termed the Catherine wheels of the heavens, for in both cases the whirling movement is due to a rapid spin combined with an outward force of explosive intensity.

Let us consider what must have happened if our ancestral sun had been encountered at close quarters by another celestial wanderer in space. As the stranger entered the danger zone, the sun would become subject to a powerful attraction which would ultimately overcome the resistance of the outer layers and force them to yield. The upheaval would begin as a gigantic tide directed towards the stranger on the near side and away from it on the far side. As the body continued to approach, the tidal protuberance would be torn away from its molten parent and two flaming arms would be explosively projected. Then, as a consequence of the sun's rotation, the streamers would begin to curl, like the sparks from a Catherine wheel, and out of the chaotic turmoil a pair of spiral arms, fed by the continued outbursts of matter, would gradually emerge and envelop themselves about the shattered sun.

By Permission of the Royal Astronomical Society

The Whirlpool Nebula

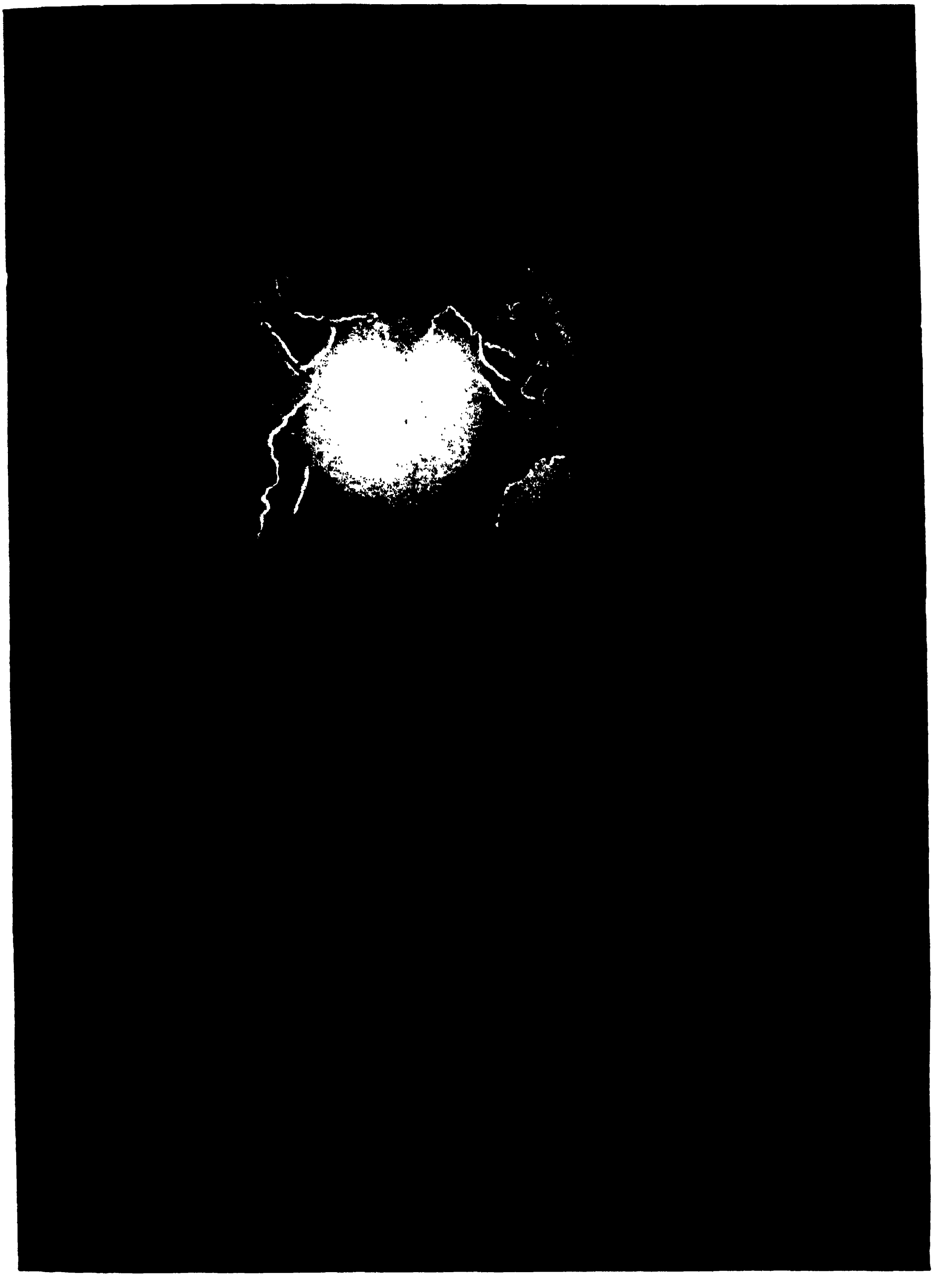
The earth began as a nebulous knot, in a whirl of meteoric streams of solar matter such as this

In this way it is explained how the sun came to be encircled by the material which now makes up the planets. When it is remembered that the latter contribute only one seven-hundredth part of the total mass of the solar system, it will not be surprising that the catastrophe required to tear away this tiny proportion of the original sun was probably not a very serious one. The simple concept of a close approach affords an ample explanation without invoking the remoter chance of an actual collision.

We now turn to the second stage of planetary evolution. Exposed to, and chilled by the cold of outer space, the material of the spiral arms would rapidly condense to a whirling crowd of meteorite-like bodies, each having its own orbit about the sun. Most of these embryo planets or planetesimals would be quite small, but among them would be scattered a limited number of larger bodies corresponding to the irregular knots of an actual nebula, and representing the nuclei of the future planets and satellites.

Within such a planetesimal swarm collisions would necessarily be of frequent occurrence. The larger bodies would capture their smaller companions by virtue of their superior powers of attraction, and with each impact the work of construction would be helped forward. In the long struggle for life and supremacy, the final advantage thus lay with the larger bodies. Circling around the sun, time after time, they would gradually sweep up all the lesser planetesimals in their immediate neighbourhood, until at last only the planets and their satellites survived.

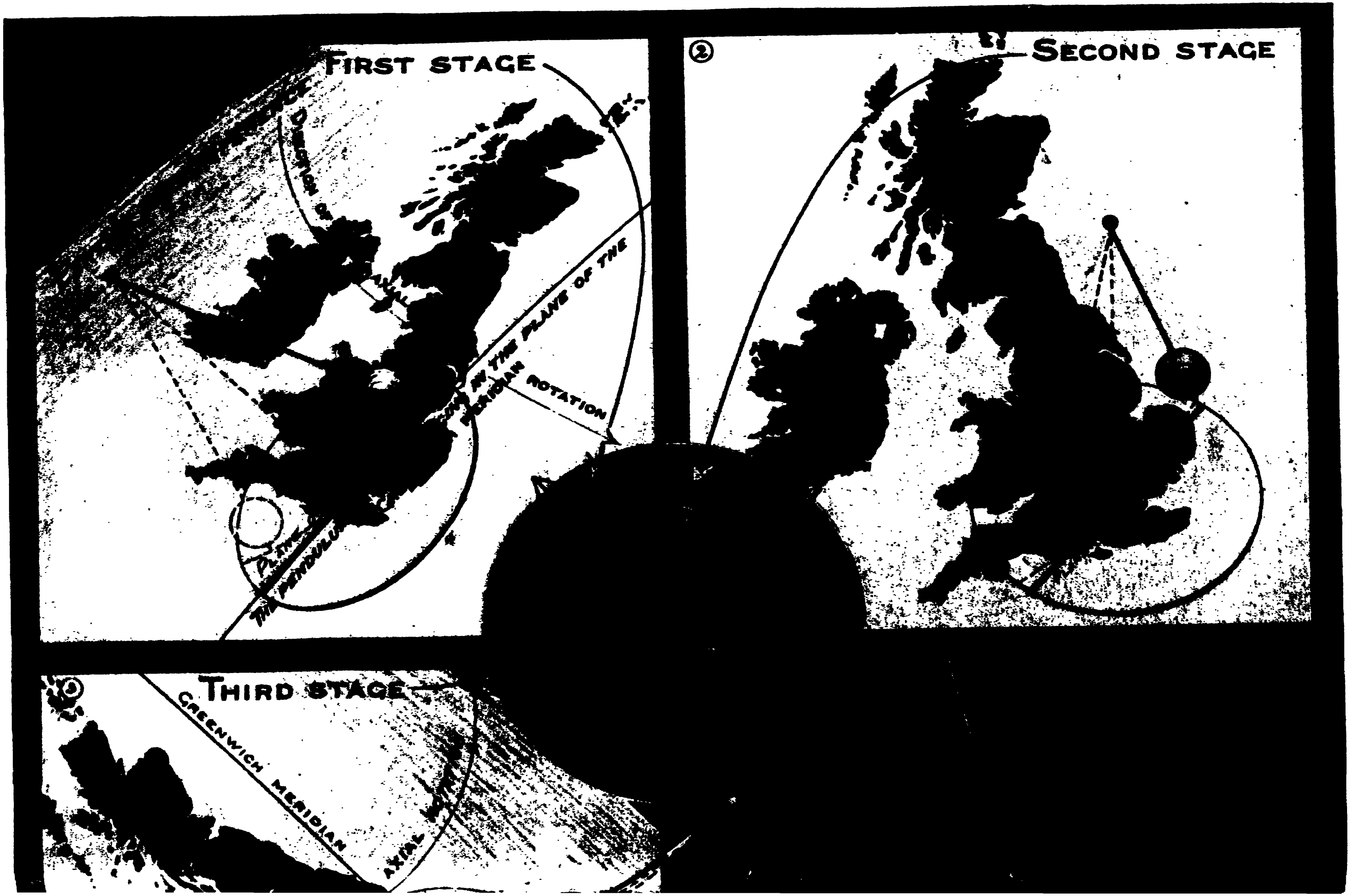
The satellites evidently represent a number of smaller nuclei which, although they were able to avoid being fused with their more powerful neighbours, were never-



How the Weight and Growth of Our Planet are Constantly Increased

(Drawn by Scriven Bolton, F.R.A.S.)

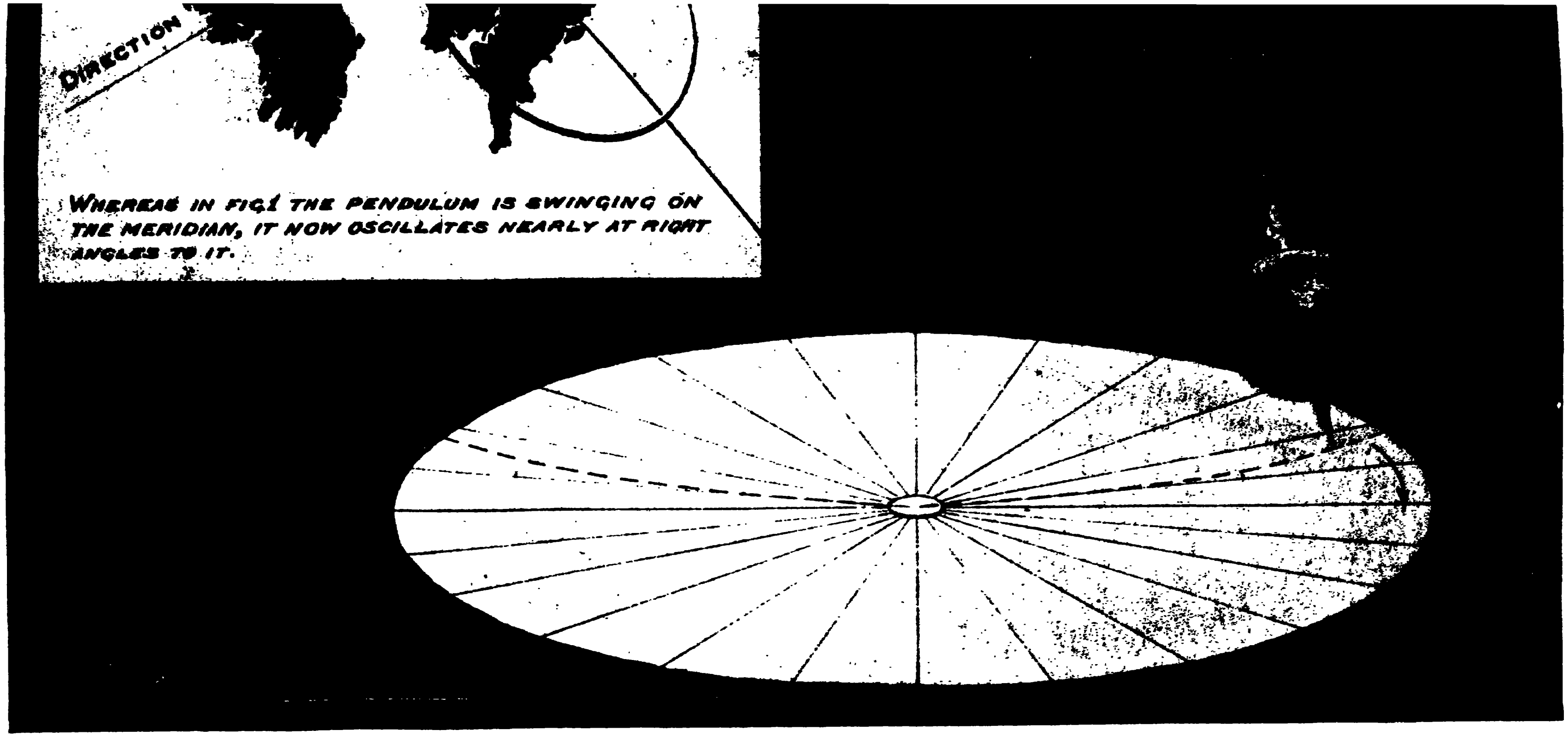
Although, practically speaking, the earth reached its maturity at least 1,500 million years ago, its period of growth is not finished. In the course of a year 20,000 tons of cosmic dust—caused by the disintegration of thousands of shooting stars or meteorites which enter our atmosphere daily—are added to our planet's weight



FIRST STAGE

② SECOND STAGE

③ THIRD STAGE


DIRECTION
WHEREAS IN FIG.1 THE PENDULUM IS SWINGING ON THE MERIDIAN, IT NOW OSCILLATES NEARLY AT RIGHT ANGLES TO IT.

How to Watch the Earth Go Round — An Interesting Experiment

(Drawn by Scriven Bolton, F.R.A.S.)

Describing this drawing, Mr Scriven Bolton writes: "By fastening a dumb-bell, or a cannon-ball, to the end of a piece of string which is tied to something rigid, the actual rotating of the ground beneath us can be seen. We know that if a pendulum of the kind above named is given a straight swing, it will continue to swing true until it stops. Now let us mark the exact spot over which it swings, and a few minutes will suffice to show that it is not oscillating over the same spot, but that its plane of oscillation seems to be drifting round in a clock-wise direction. If the pendulum can be made to swing for several hours, it will appear to have a rotatory motion, as shown in Figures 1, 2, and 3. What happens is this. The world is going round, the ground beneath us is going with it, but the pendulum does not participate in this rotation from the very fact that it is swinging. As our isles begin to heel over, the direction of the swinging remains perfectly constant, and, whereas the pendulum apparently rotates clock-wise, it is stationary, the movement being in everything around us, which is carried round counter-clockwise with the world" theless incapable of pursuing an independent path of their own. Each one was therefore obliged to attach itself to a planet, signifying obedience by accompanying its master in the periodic journey around the sun.

Thus was built up the solar system according to the Planetesimal Hypothesis, as the theory has been christened by its eminent author, Prof. Chamberlin. The many difficulties which proved so embarrassing to the Laplacian Hypothesis are here successfully avoided, and although Chamberlin's views have not yet stood the test of a century's criticism, it is generally agreed that of all the attempts to grapple with this formidable subject, the Planetesimal Hypothesis is by far the most convincing.

The earth, then, began as a nebular knot, surrounded on every side by streams of meteoric matter. By the force of gravity the latter were slowly aggregated into clusters, and these in turn were drawn in by the earth until our planet finally attained to its present size.

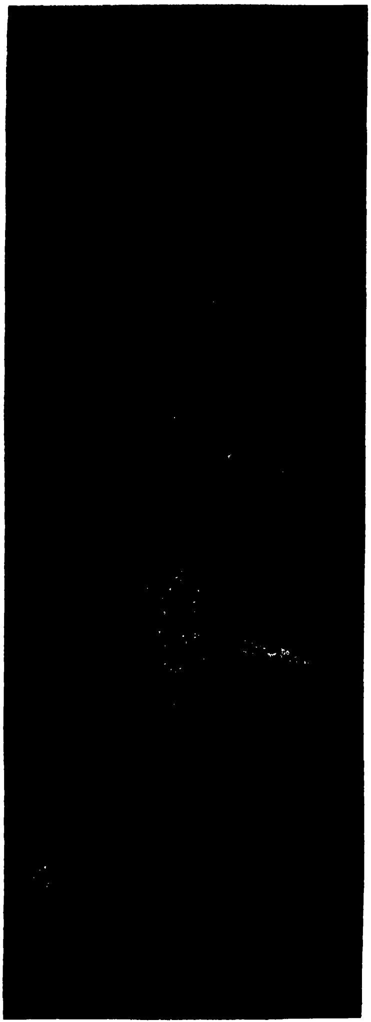


Photo by F. Hollyer

The Creation of Man

(Painted by Sir E. Burne-Jones, Bart.)

Indeed the earth has not yet finished its period of growth, although at present its progress is negligibly slow. The fall of a shooting star or meteorite, as it traces out its fiery path through the upper regions of the air, is familiar to everyone, and it is obvious that the earth must be constantly adding to itself by the capture of these tiny wanderers. In the course of a year 20,000 tons are added in this way, but so enormous is the weight of the earth —6,000,000,000,000,000,000,000 tons—that even after the accumulation of thousands of millions of years, no appreciable difference would have been made. All the material which has fallen from the sky, since the dawn of the earth's historical period, would cover the globe with a blanket of cosmic dust probably not more than a few inches thick. Practically speaking, the earth reached its maturity at least 1,500 million years ago. How it is that the earth has recorded this enormous lapse of time must be explained in a later article.

Spectrum of a Nebula

By Arthur Twidle

The Owl Butterfly.

In the centre of each hind wing is a large eyespot. If the huge Caligo Butterfly rests head downwards and with partially folded wings upon a twig it looks exactly like the face of an owl. Small creatures which would readily attack and destroy a butterfly of ordinary mien are scared away by one which suggests a well-known bird of prey.

The Owl Butterfly

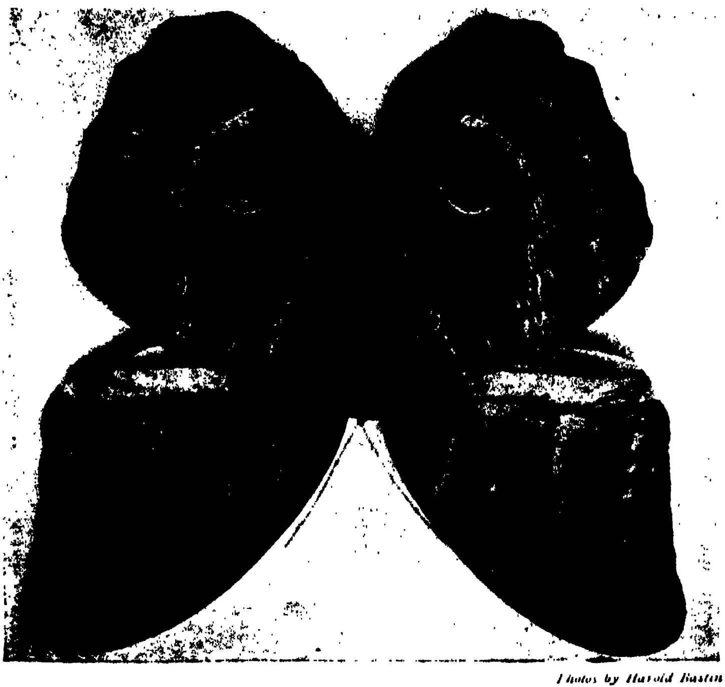
Eye-spots on Insects' Wings

By HAROLD BASTIN

Author of "Insects: Their Life Histories and Habits," &c.

AMONG the patterns which have become fashionable, so to speak, with butterflies and moths, none is more remarkable than the so-called eye-spot, i.e. a more or less circular grouping of colour, edged with white or yellowish-white, which presents the appearance of a staring eye. We see such marks on the wings of our own emperor moth, not to mention the well-known meadow-brown butterflies and their kindred.

It is in the tropics, however, where the struggle for existence is far more fiercely contested than in temperate regions, that eye-spots are most noticeable. Hundreds of species, which differ widely in every other respect, agree in possessing these striking devices. Not infrequently the general tinting of the wing-area is subdued—designed, as it were, to harmonise with the insect's customary surroundings; but the eye-spots are invariably conspicuous and arresting. Sometimes the centre of the spot is without colour and perfectly transparent, so that the wing seems to be fitted with a kind of glazed port-hole through which the light shines strongly. In other instances the spots coalesce in a very curious manner, and resemble strange geometrical designs or printed characters. In South America, for example, we find a whole group of butterflies which display the figures "80" (or it may be "88") on the under side of each hind wing. Indeed, we may say that Nature is a veritable specialist in eye-spots, and has elaborated every conceivable variety and combination.



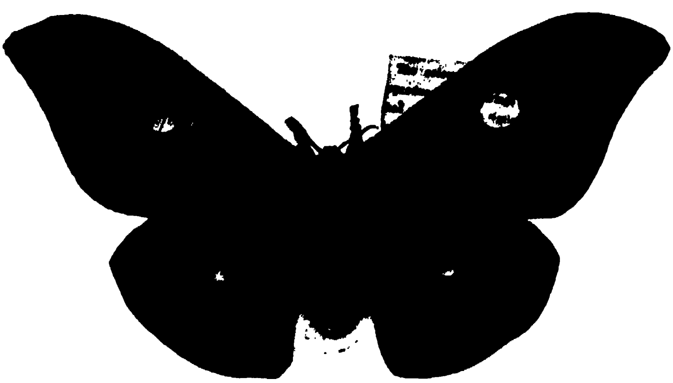
Photos by Harold Bastin

The Owl Butterfly

Slightly bend the paper to observe its amazing resemblance to the face of an owl

Probably her most striking achievement is seen in the case of certain tropical American butterflies of the genus *Caligo.* They are large and handsome, the upper

The Owl Butterfly

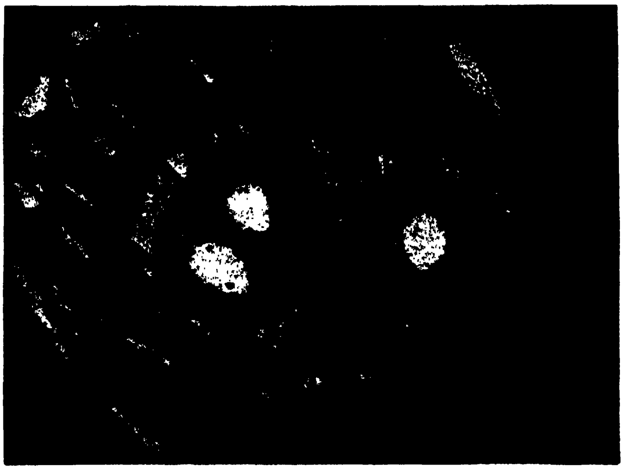


Sometimes the wing is fitted with a glazed port-hole through which the light shines and print can be read easily

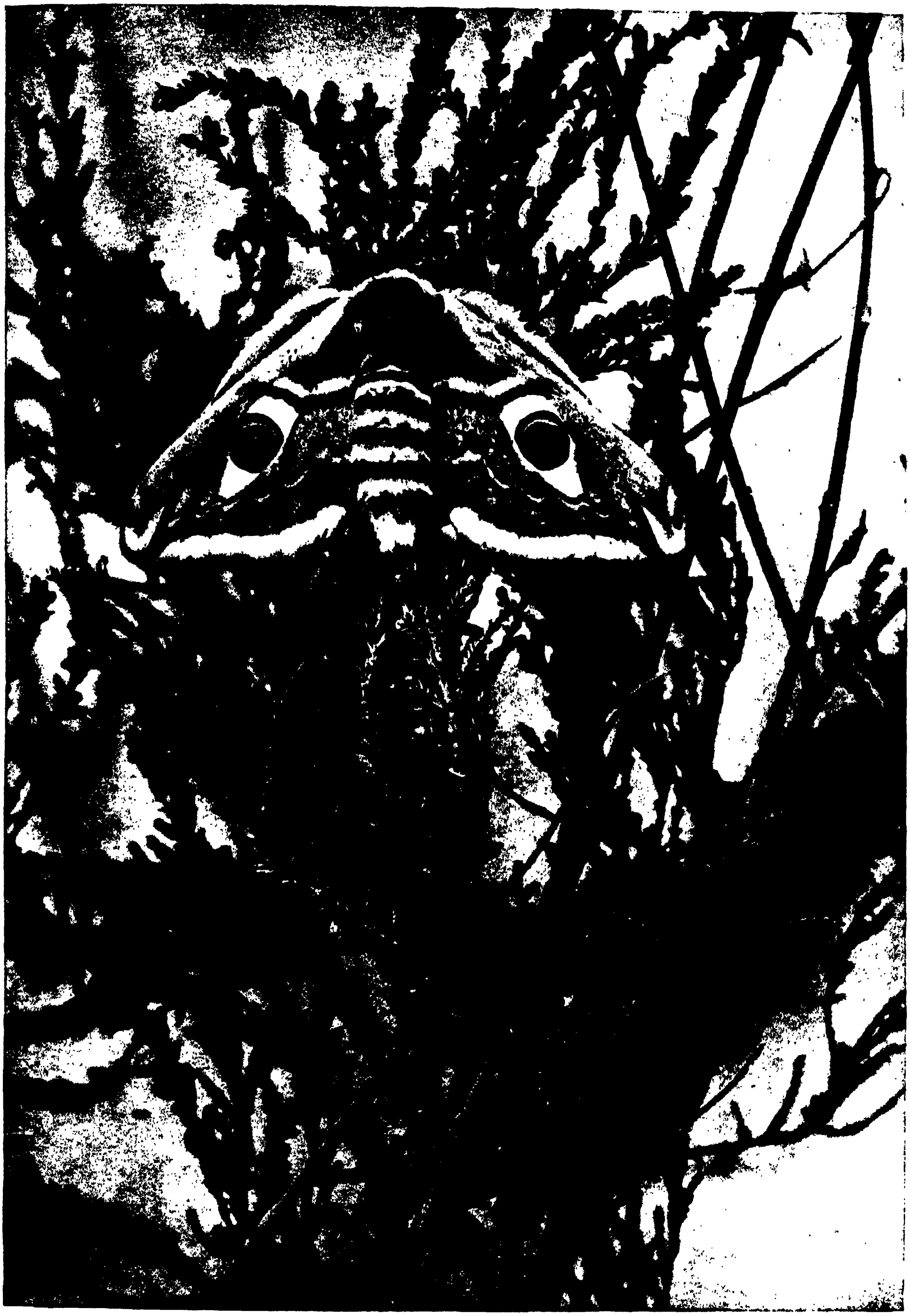
surface of their wings being usually adorned with blotches or bands of lustrous blue or purple; but the under surface displays only a sober mottling of greys and browns, except that in the centre of each hind wing there is a huge eye-spot. Thus, if the creature chances to rest head downwards, and with partially folded wings, upon a twig, it looks exactly like the face of an owl. The resemblance is so remarkable that it at once suggests the name "owl butterfly," by which these insects are popularly known.

The question now arises: What can be the meaning of these wonderful eye-spots on insects' wings? Such very striking markings cannot have become characteristic of large families of butterflies and moths merely by chance. We need not assume, however, that a single explanation will meet all the facts of the case, for in all probability the eye-spots of insects are serviceable in more ways than one. For example, they may play the part of the bull's-eye in a target, and thus serve a protective office by directing attention from vital parts of the body. This suggestion was made by no less an authority than Darwin. The strategy would work in the following way: Suppose a bird, when in chase of a butterfly, were to pierce one of its eye-like spots, little damage would be done to the insect, in fact, the latter would actually gain time to evade its pursuer; whereas its fate would be sealed if the bird struck at and injured its head or its body. Thus, a prominent spot, with a deceptive appearance of vulnerability, might very well save the insect's life. As a matter of fact, naturalists in tropical countries have noticed that many of their captures have their wings torn and punctured in the very places where the eye-spots occur.

This theory, however, would only apply when the eye-spots are visible during flight. In other cases, i.e. when they become conspicuous as soon as the insect assumes its customary attitude of repose, they probably serve to alarm inquisitive birds and other insectivorous creatures. Certain large moths, which hide in crevices by day, resemble the heads of lurking serpents in a most startling manner. Again, in the case of the "owl butterfly," creatures which would attack and kill an insect of ordinary mien are scared away by one resembling a bird of prey.



In South America a whole group of Butterflies display the figures 80 on the under side of their wings



Female Emperor Moth, newly emerged from the Cocoon (on the right)

Being unable to fly as yet, she depends upon her eye-spots to keep marauders at a distance

A VEGETABLE GIN TRAP

By S. L. Bastin.

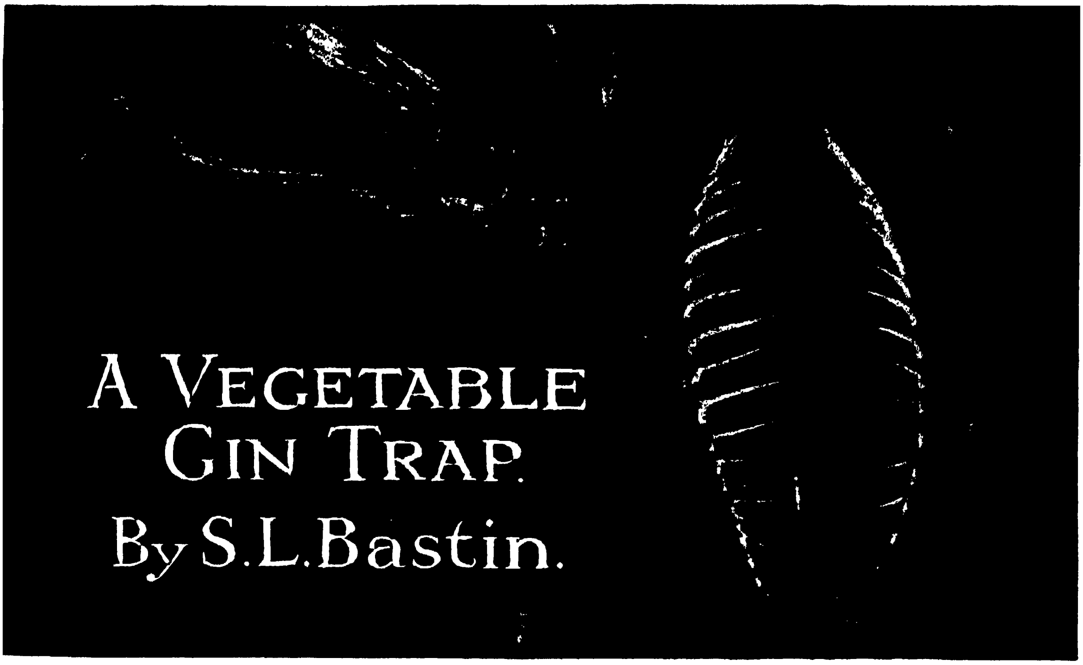


Photo by S. L. Bastin

Venus Fly Trap

First Stage.—When fully expanded the leaf lies back on the moss, amongst which the plant grows. The red area on its lobe seems to possess great attraction for insects. Note the three hairs arranged in triangular fashion

IT is curious in how many ways Nature has forestalled human invention. Quite one of the most singular instances of this is to be seen in a little plant which is only found growing in the bogs of Carolina. This has been rather cynically called the Venus Fly Trap (*Dionæa muscipula*), a fanciful name which hides the identity of perhaps the cruellest plant in the world.

The practice of fly-catching is, of course, widespread in the vegetable kingdom, but few plants have adopted a more certain plan than the Dionæa. Every leaf which the plant produces is the most perfect device for the securing of prey that could be imagined.

The mechanical construction of this remarkable vegetable trap is somewhat on the following lines. The leaf is borne at the end of a curiously broad stalk, and is divided into two lobes ; these are joined together by a hinge-like arrangement. The outside borders of the lobes are fringed with from a dozen to twenty long teeth. When fully expanded the leaf lies back on the moss amongst which the plant grows.

If now we examine the inside surface of the lobes we shall see that these are in the middle coloured a rosy red. Just at this point will be discovered three hairs arranged in triangular fashion.

It is interesting to consider the actual manner in which the plant carries out its fly-catching.

As is well known, bright colours have a great attraction for insects. In this case it is apparently the red areas on the lobes of the leaves which possess such an attraction for insects of all kinds. Possibly they secrete a sweet substance, but this is not definitely known. All goes on well as long as the creatures avoid doing one thing ; unhappily, this they are almost

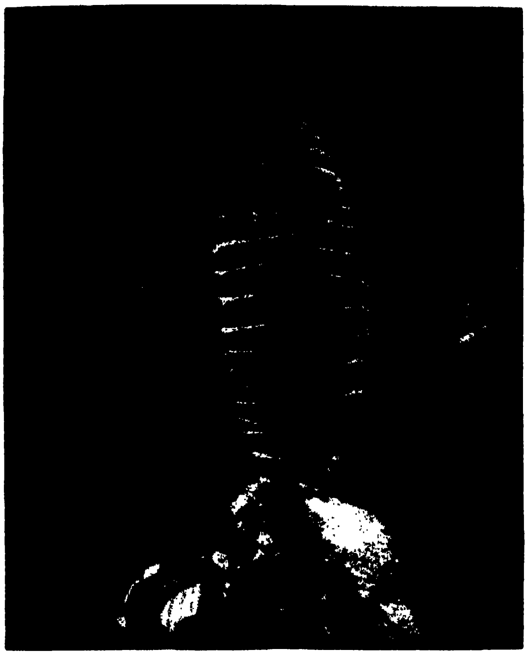


Photo by S. L. Bastin

Second Stage

With really astonishing rapidity the sides of the leaf snap together so that the spines on the borders of the lobes meet, and any sort of escape is absolutely impossible

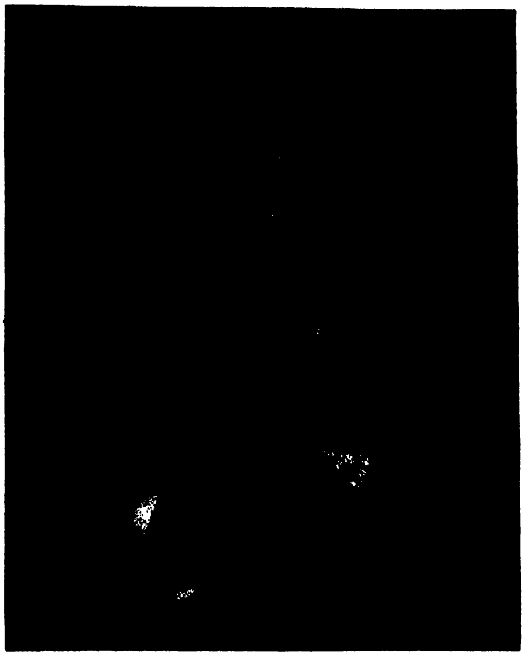


Photo by S. L. Bastin

Final Stage

During the next half-hour the sides draw in still closer, so that the spines overlap. The Dionæa then proceeds to "digest" its catch

certain to do sooner or later. Nothing happens unless the insect brushes up against one of the hairs previously mentioned as being on the surface of the lobes. The succeeding happenings are disastrous for the fly.

With really astonishing rapidity the sides of the leaf snap together so that the spines on the borders of the lobes meet. Thus, in a very brief time a most perfect little cage is devised, from which any sort of escape is absolutely impossible. During the next half-hour the sides draw in still closer, so that the spines overlap. At this stage the leaf pours out a copious discharge of a digestive fluid, which enables the plant to make use of the nutritious element in the fly.

After an interval of several days the leaf of the Dionæa opens, and allows the hard carcase of the fly to roll away. The plant is then ready for another meal, and, unable to realise the fate which is in store for it, another fly falls a victim. Quite often the Venus Fly Trap is able to capture large insects.

The writer was recently fortunate in being able to secure photographs of a very fine catch on the part of a Dionæa leaf. This was a bluebottle fly, which was tempted to explore the inside of the trap. Of course, being so large, the insect blundered at once against the sensitive hairs. The terrible jaws closed on the fly in a fatal embrace, so that not even the struggles of the victim had the least effect. Finally, the sides of the leaf were able to draw close together, and after about a week there was nothing left of the fly but a few dry, crumpled remains. Experiments with this strange plant showed that whilst the blades would enclose small pieces of stone, for instance, yet these would not be retained for any length of time. A short while after acceptance, the blades will slowly open and permit the undesired substance to roll away.

II.—In the Underworld : Natural

ICE CAVES

by E. A. Baker M.A. D.Lit

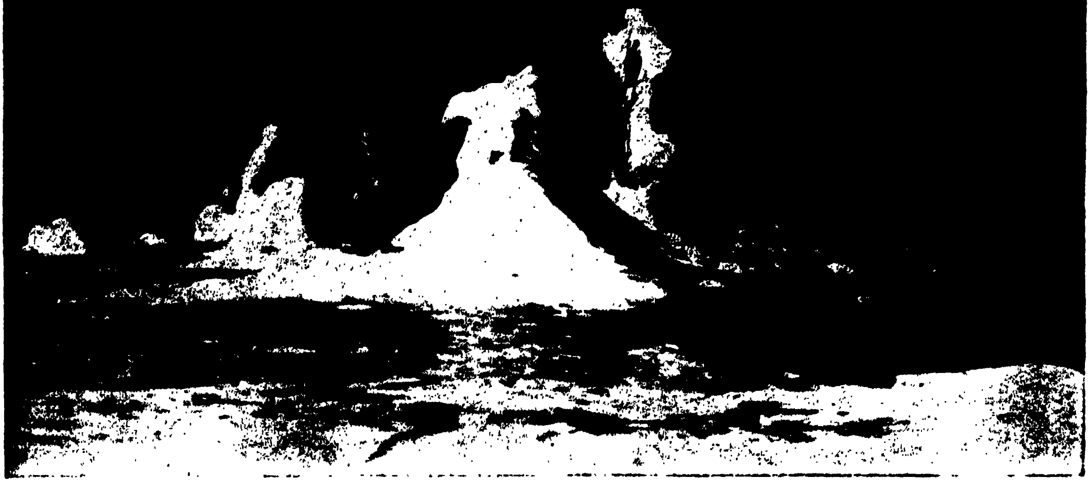


Photo: E. A. Martel

Ice Cave of Grâce Dieu

Inside it is always winter. Even in summer (when this photo was taken) it is filled with perpetual ice

ONE of the most distinctive and curious kinds of cavern, and one which is found in most parts of the globe where the right conditions prevail, is the Ice Cave.

The first of the requisite conditions is either an altitude above sea-level or a distance from the Equator sufficient to produce a severe temperature in the winter. If in addition cavities exist below the surface with a small and sheltered orifice above and no open exit below, they are pretty sure to be ice caves. During the winter, intensely cold air rolls down into such cavities, and during the summer the warm air, being lighter, is unable to penetrate into the interior and expel it. In these natural refrigerators, accordingly, the temperature never rises much above that of mid-winter; in most cases, observation shows, it remains even on the hottest days steadily at or about freezing point.

The best known examples of ice caves are in the Jura and among the Alps of Savoy; several have long been a source of considerable profit to their owners by supplying ice in the summer to Geneva and Lyons.

There are some, which are quite easily accessible to tourists, on the well-known Rochers de Naye, near Montreux and Lausanne. But perhaps the most celebrated of all is that of Grâce Dieu, near Besançon.

The mouth of this cavern is of an imposing type not at all uncommon in our own country. One side of a great yawning cavity in a wooded mountain-side is a steep slope, 420 feet long, down which the visitor scrambles and zigzags underneath a big arch formed in the opposite wall of the cave-mouth. Trees and the situation give shelter from the sun and from the prevailing winds, with the natural consequence that inside it is always winter, and half-way down the slope a sheet of perpetual ice stretches into the rugged vault below, the floor, walls and roof of which are plastered with ice. The striking photograph at the head of this article was taken there in summer by Mons. Martel, the famous French spelæologist.

In caves of this nature ice assumes the fantastic and ravishing forms characteristic of limestone caverns. Sometimes the stalactites and filigree of the limestone carbonate are visible deep below the transparent masses covering the rocks. But the ice itself forms pendants like stalactites, where water exudes from the roof, and the continual drip falling to the floor causes stalagmites of ice to spring up, which in this cavern of Grâce Dieu tower in vast columns and pyramids almost to the roof. Nature here has been assisted to some extent, for since the place became a show cave the size of these ice masses has been increased by means of stakes, and even tree-trunks, fixed as a nucleus for the ice to gather round in the winter, with very picturesque results.

The ice caves of this region are known locally as glacières. One might describe the deep bed of ice that almost fills some of them as a genuine glacier, for most of the features are found here of a glacier in the high Alps. In the early summer deep beds of snow remain unmelted, and immediately beneath this the compressed névé—snow which is being converted by pressure into solid ice—is of the same composition as that which covers the upper slopes of Mont Blanc and Monte Rosa. Then comes the ice, layer upon layer, pitted by those strange crevasses called moulins, or water-mills, which are always present on glaciers, carrying the surface water down into the mysterious region below. There are caves where the explorer is able to climb to a depth of 80 feet below the upper ice-floor, and sees the front of this subterranean glacier rising like a cliff before him; but the bottom remains inaccessible, and there is nothing to indicate where the ice comes to an end.

Photo. Underwood & Underwood

An Ice Cave in Brigsdale Glacier

Streams that take their rise from such sources are intensely cold, whatever the time of year

Streams that take their rise from such sources are intensely cold whatever the time of the year. It is the great accumulations of everlasting ice and snow lodged in

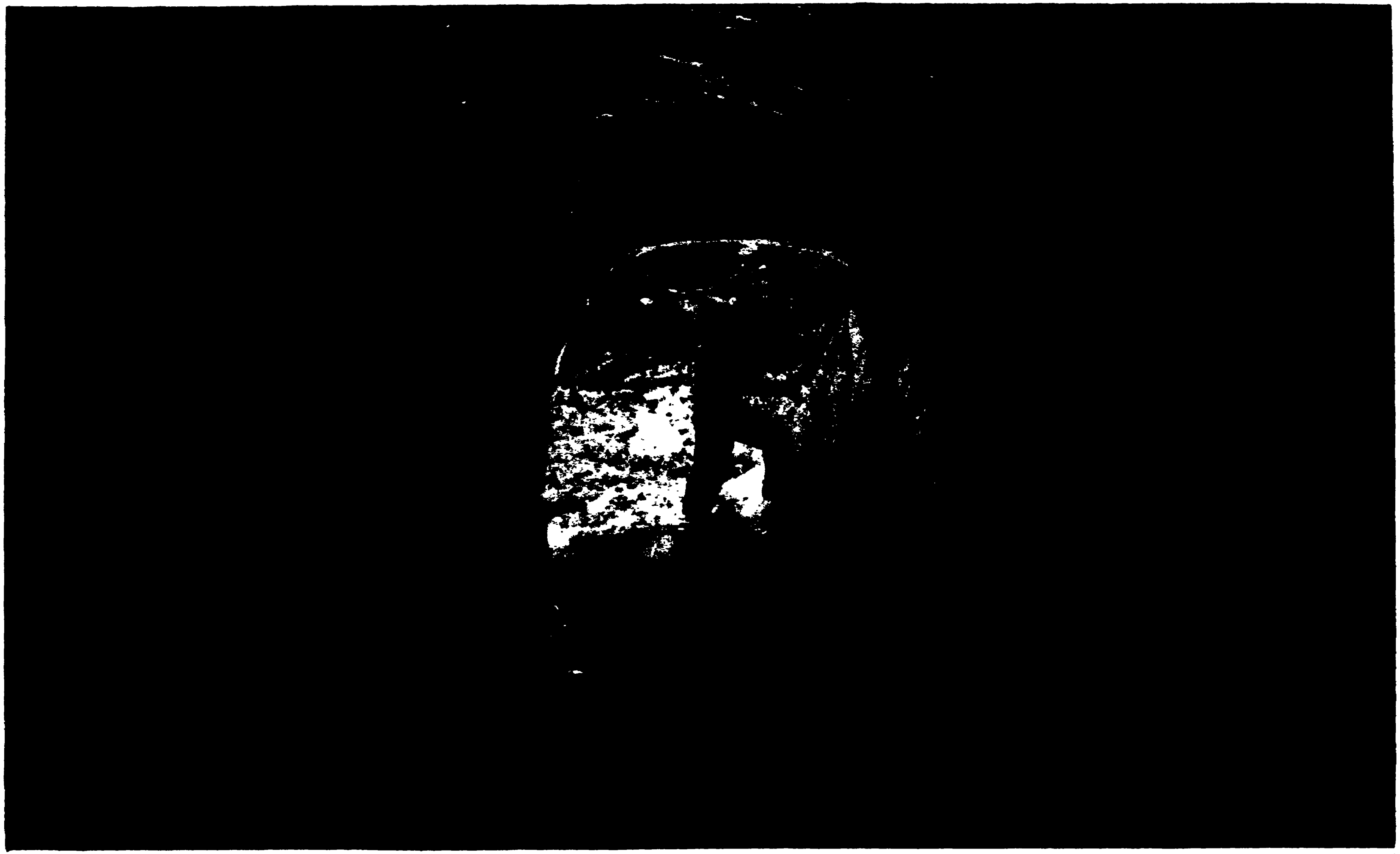


Photo: Underwood & Underwood

A Cave in the Ice

A cave in the ice of the Lower Glacier at Grindelwald. This is quite a different thing from a true ice cave the mighty rifts of the Oucane de Chabrières that give such a refreshing temperature to the famous Fountain of Vaucluse. In the heat of summer the shepherd loves to climb down into the more accessible of these grim fissures to get ice for cooling the wine in his gourd.

A very extraordinary but universal belief in the districts where these caves are common is that the ice in them is formed, not in the winter, but in the summer. It is a superstition easy to account for. As a rule, the inhabitants observe, quite correctly, a much larger quantity of ice is found in these caves during a hot, dry summer than during a cold and wet one. As already explained, the heated air in summer cannot get into the cavities to melt the ice; in fact, such thawing as does take place is due entirely to the water that soaks through the rocks or gets in by way of fissures. In a cold, wet summer there is abundance of moisture, and the destructive agency of water comes freely into play; during a hot summer the stream-courses are dry, and the ice remains unattacked. No wonder that ignorant peasants should be utterly bewildered and misled by this strange consequence of natural laws.

Besides the Jura, the Alps, and even hills of such moderate height as those of the Côte d'Or, near Dijon, the Carpathians, and the Crimea have a number of ice caves. That of Dobschau, in Hungary, is renowned for the strangeness and magnificence of its scenery. There is one at the height of 11,040 feet above the sea on the Peak of Teneriffe, and another at almost as great an altitude in Turkestan, the latter believed to extend as far as Cabul. No one has yet ventured, however, to attempt to make a through route, because Shetan is understood to have shown himself there in person in quite recent times, and not a native can be induced to act as porter.

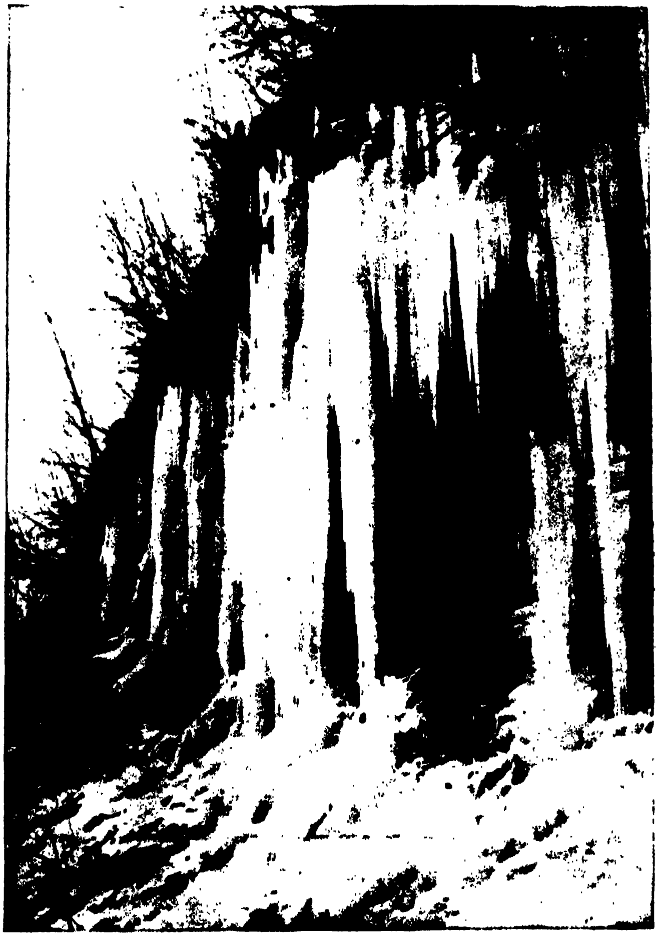


Photo by Underwood & Underwood

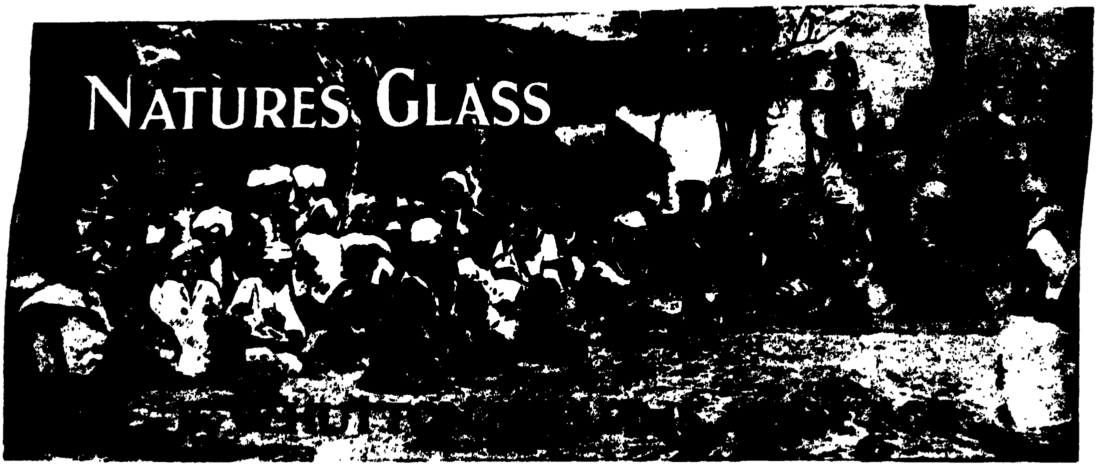
The Devil's Organ

In the valley of Great St. Bernard planes of ice are formed in winter 100 feet and more in length. When the wind whistles through the gorge it plays such eerie and terrifying music on these pipes that it is hardly surprising the peasants speak of them as the devil's organ

The ice-caves of America are mostly very tame affairs, though useful for the supply of ice at the season of high prices. Much more wonderful is the ice cave existing in one of the lava tunnels of Iceland, which is recorded in the sagas as the abode of a fearsome giant.

II.—In the Underworld: Artificial

NATURES GLASS



Photos by permission of Messrs. F. Wiggins & Sons

The Most Versatile of Minerals

Natives cleaning and trimming mica. A plate of the thickness of a page of this volume can be split, resplit and split again and again

THOUGH mica is one of the most widely-distributed of minerals, and enters into the composition of a very large proportion of the rocks of the earth's surface, it has physical properties so unique as to make it stand alone, a law unto itself in the mineral kingdom.

Its commercial uses are widespread. Great industries are dependent on it; skilled professions find its use a necessity; and the physical scientist, the student of light, heat and electricity, could not get on without it. Large communities, in various parts of the world, are supported entirely by the mining, dressing and selection of this mineral for the market.

Mica is an important constituent of all granites. You may see the dark specks of this mineral in the polished surfaces of the granite fronts of shops, banks and offices as you pass along the street each day; but it is from the "Pegmatites," or giant granites, in which the crystals of quartz, felspar and mica, of which they are composed, run from the size of a man's palm to blocks weighing several hundredweight, that the large-sized crystals of commerce are obtained.

These pegmatites, or veins and bosses of giant granite, usually occur in normal granites, schists and gneisses, and are mined for mica in portions of the earth's surface as widely separated as Russia, India and the United States of America. The earliest known mica came from Russia. Hence the name "Muscovite," the "Muscovy Glass" of the middle ages. There are several varieties of mica, among which Muscovite, Biotite and Phlogopite are the most important. The variety best known to commerce is Muscovite.

Mica occurs in the pegmatites in short prismatic crystals, roughly six-sided in form. These are known as "books" from presenting the appearance, as they lie in the pegmatite, of books irregularly piled one on the other; as well as from the appearance of the edges of the cleavage-planes on the sides, which is like nothing so much as the pages of a book viewed from the edge.

This ability to split in perfectly even planes in one direction is one of the peculiar physical attributes of mica. The quality of cleaving in definite planes is shared by other minerals; but in no other is the perfect cleavage of mica attained. These cleavage planes, moreover, are so close together that a plate of the thickness of a page of this volume can be split, resplit and split again and again, always giving the same perfectly smooth and splendently lustrous surface. Such leaves or cleavage-fragments are more flexible and elastic than paper itself, and transparent as glass.

All mica shows colour in thick slabs. This colour ranges from a delicate lemon-yellow, or a pea-green, to dark green, brown, or a rich ruby red. The finest ruby Muscovite comes from the Hazaribagh district of Bengal, in India, where it is mined over a large area. High explosives are used in sinking the shafts and driving the galleries in the hard pegmatite to get at the mica scattered through the mass, and many a fine book has a drill driven through it, or is shattered, in the process.

The whole community in the district around the town of Koderma, the centre of the industry, is engaged in the mining and dressing of the mineral; and the plain for miles, between the railway and the mines, shimmers in the sun from the scintillating fragments or flakes of mica which have been scattered over it by the wind. It is as impossible to let the eye rest on a heap of mica-waste in the distance as to look in the face of the sun himself.

The miners are engaged in the bowels of the earth at depths up to 250 feet or so, or in great open-cast quarries. The women pass up and down primitive ladders carrying the material excavated and accumulated water in baskets and "chatties."

The day's find of mica is carried several miles to the "go-down," or factory at sundown, on the heads of the members of each gang of workers. The large sizes in bundles fastened together with wild vine or bark, and the smaller sizes in baskets of cane.

The mines themselves are very scattered and lie for the most part in dense jungle, the haunt of wild beasts and a favourite hunting ground for the Englishman stationed in the vicinity. The tiger, leopard and wolf take heavy toll each year. Woe betide the miner who, from desire of personal gain, or fear of theft, stays on at the mine to secure a promising book, if he be tracked by one of these denizens of the jungle on his way to the "go-down."

Primitive Pumping

The women pass up and down ladders, carrying the excavated material and accumulated water

The mica goes next to the selectors and cutters. It is split down to slabs about one-eighth of an inch in thickness and classified according to size and quality.

Clear, stained, slightly stained and speckled are well-known terms in the market. While very large sizes are occasionally found, those usually supplied to the market are from A1 (48 square inches and up), and No. 1 (36 to 48 square inches), down to No. 6 (1 to 4 square inches). The slabs are irregular in shape, the edges rough dressed only with a sickle. Clear slab commands a higher price than stained, as it is suitable for certain purposes where a high degree of transparency is required.

Beautiful Inclusions

The markings are usually due to inclusions of other minerals in the crystal. Beautiful dendritic or fern-like forms, due to manganese, are common, and also inclusions of the gem-stones tourmaline and garnet. Such mica as is not fit for the slab market is passed on to the "splitters." These, who are principally young girls and children, split the mica down with a pointed style and the fingers to the thickness of thin paper. Such splittings are known as "phutnees" or films. The films must be of even grade, and the workers cultivate a delicate sense of touch by which they are able to estimate the thickness with an extraordinary degree of accuracy.

The demand, in recent years, for children for this work has created locally a curious inversion of social life. One finds parents living in idleness supported entirely by the earnings of their children. The waste heaps have been turned over and over and large recoveries made.

The largest users of mica are manufacturers of electrical machinery of all kinds. It is one of the best insulators known, and all attempts to produce artificially a substance which will combine its properties of resistance towards both heat and electricity have failed. The sections of the dynamo-armature and conductor-coils of the motor are insulated from each other with mica. If you ride in an electric tramcar or train, it is revolving in the motor beneath you. It is used in the construction of the magneto of your motor-car, and in almost all electrical measuring instruments. Large round conductors are insulated with mica-tubes, and flat areas are separated from each other with "micanite."

It is for this article that the films are required. Micanite is made of these small, thin laminæ of mica re-assembled into a sheet and cemented together with an insulating gum under great pressure and high temperature. The insulation resistance of this material is so great that the pressure required to pierce a sheet of it is 1,000 volts for each one-thousandth of an inch in thickness.

The clear slab is used for many special purposes. Its resistance to heat enables it to be used in anthracite, gas and oil-stoves, and for the sight-holes of furnaces. The so-called "talc," lamp or incandescent-gas-light, chimney is made of mica. Mica is used in laboratories as a heat screen for furnace work. Opticians make use of it in many ways. Mica goggles for motoring are familiar. Mica masks for sand-blast work less so. The windows of the diver's helmet and those of the fireman and of the rescue-apparatus of the miner, are made of mica, and so is, often, the compass card of the mariner.

The "Mica Van"

We have traced the slab and the films, but what of the waste? You may have seen the legend "Mica Van" printed in small letters on a covered rail way wagon. This is for goods which are perishable, or which are liable to become damaged or dangerous when heated. It has an inner and outer shell, and the space between these has been filled with mica-waste.

Mica-waste is used in the manufacture of fire- and heat-resisting materials of all kinds, the making of steam-engine packings, the isolation of cold-storage rooms, and for roofing in hot climates. This extraordinarily versatile material is also used in the form of mica-dust to produce beautiful effects in connection with theatrical scenery.

A Mica Mine

The mines are very scattered and lie for the most part in dense jungle, the haunt of wild beasts and favourite hunting ground for the Englishman stationed in the vicinity

Portion of a Thirteenth-century Map of the World

The "Mappa Mundi" at Hereford Cathedral, dates from 1275 1300. It attempts to represent the whole world, with its main features, peoples and products. A glance at the Mediterranean Sea reveals how grotesquely it is distorted

The Great Discoverers—I

How Man has Triumphed over the Ocean and other Natural Barriers and Discovered the World

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

THERE may have been mute, inglorious Miltons, whose lovely or inspiring thoughts either were never put into words or, being worded, perished because they were not written down, printed, or permanently preserved to us. So there have been, no doubt, in the whole history of Man marvellous discoverers who have passed unrecorded.

Can we not imagine in the dim ages of prehistory, heroic adventurers arising amongst the Eolithic, Palæolithic, and Neolithic human tribes, who led their people like another Moses or Joshua into a land of promise? Bold, no doubt, was some adventurous young Eoanthropos who crept through the forests that once filled the bed of the English Channel and emerged on to the grassy downs of Sussex, Hampshire, or Kent.

Here he saw herds of big and small game feeding, which made his hungry mouth water. It may be that when he had satisfied his cravings he returned to the clan still settled in over-populated French caves, and by gesture and guttural exclamations indicated that there was a land of promise to the north and west, and so began the peopling of Britain. And again, these Eolithic creatures when they had exhausted Essex, Suffolk, and the Midlands, Wales and Yorkshire, penetrated farther and farther north, till their Palæolithic descendants actually reached the Shetland Islands (then a scarcely broken peninsula), or passed through Galloway, across the isthmus that led into densely forested Ireland, a land swarming with gigantic deer.

Palæolithic adventurers crossed Central Asia, invaded Kamschatka, journeyed by stages over the Behring Isthmus into a more genial Alaska than exists at the present day, in one of the warm intervals between the ice ages.

Strandloopers, clever as draughtsmen and as fashioners of the better class of Palæolithic implement, made the journey from Cairo to the Cape, not perhaps as individual pre-Stanleys or proto-Livingstones, but by generations of irrepressible adventurers. Earlier but perhaps even bolder folk passed on south-eastwards from Java over land bridges just breaking up, and by means of rude rafts and floating logs, till they had colonised New Guinea and entered the Australian continent.

From New Guinea again, wave after wave of adventurous naked people—Negro, Negroid, Mongoloid, Caucasoid — passed on from one archipelago, island and islet, to another, across the vast Pacific Ocean; till they had colonised the remote archipelago of Hawaii, and Easter Island, within a thousand miles of South America. We may imagine, without much risk of being wrong, that they did not stop at this, but managed somehow with their outrigger canoes and mat sails to attain the coasts of California, Mexico, or Peru, bringing with them superior notions of how to deal with stone, how to cultivate plants and tame wild animals.

Perhaps even more marvellous were the unrecorded voyages of Malays across more than 8,000 miles of Indian Ocean from Sumatra and Java to Madagascar. They may, it is true, have taken a more roundabout and northerly course, and rested and refreshed themselves on some of the small islands of the northern Indian Ocean, though little or no trace or evidence of such a course has as yet been found.

But it was not till about 1,500 B.C. that mankind became sensible of the importance and interest of geography, and took actually to recording geographical adventures and to preserving the names of pioneers in this form of research.

About the period I mention, Egypt, in one of its periodical regenerations—and such a period it is no doubt about to enter on once again under the British ægis—determined to find out more about tropical Africa and, above all, the southern coasts of the Red Sea and the promontory of Somaliland—the region which they knew vaguely as the land of Punt or Puanet, the region from which their legendary ancestors had proceeded to the Nile Valley. So they sent out maritime expeditions which obviously visited not only the south-west coast of Arabia, but the coast of the Danákil country and of northern Somaliland; they recorded the events of this voyage in still unperished engravings and papyri.

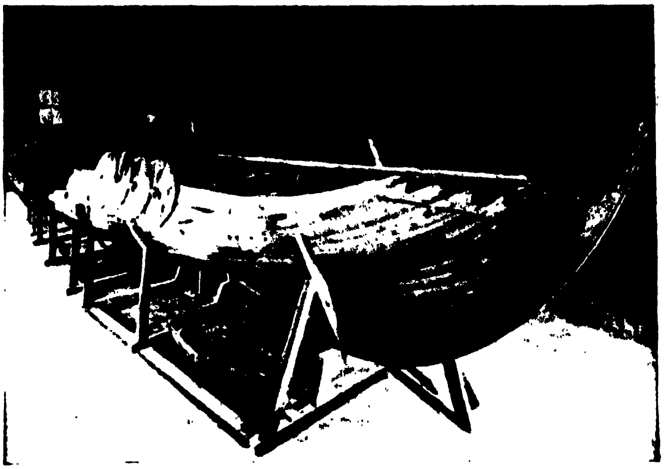


Photo: O. Vaering, Christiania

A "Viking Ship" found at Gokstad, South Norway

This ancient ship, which is entirely of oak, was found sunk in blue clay below a peat moss. Its total length is 75 feet (length of keel 60 ft.), greatest breadth 15½ ft., depth 3½ ft. It carried sixteen oars

Not long afterwards, the Phœnicians of Syria finding Syria, Palestine, Cyprus, and Asia Minor no longer sufficient for their enterprise, sent their ships westwards across the Mediterranean. No doubt they followed in the tracks of those remarkable Cretans and Mukenaians of the Minoan period, who—it may be 3,000, 4,000, 5,000 and more years before the Christian era—had in their galleys explored most of the coasts of the Mediterranean, especially its eastern half, and had brought Neolithic civilisation into Italy, Southern Spain, and North Africa. I am dealing, however, not with prehistory, but with the actual records of the world's great discoverers; and the earliest amongst these were the Egyptians, the Phœnicians, and the Cathaginian descendants of those Phœnicians who had founded colonies on the north coast of Africa. The Phœnicians discovered the south coast of France and founded the trading city of Marseilles. They likewise created most of the existing cities of any importance on the south-eastern coast of Spain, on the coasts of the Balearic Islands, Sardinia, and North Africa, right round to the shores of the Atlantic; perhaps, also, the city of Lisbon. From the coast of Portugal they passed northwards in their search for tin till they had discovered the British Islands, at any rate the south of England.

From the picture by Lord Leighton, P.R.A.

Phœnicians Trading on the Coast of Cornwall

The Phœnicians were among the first of the world's great discoverers of whose doings we have actual records

About the year 520 B.C. a great Carthaginian expedition—the Carthaginian Phœnicians had already founded colonies along the coast of Morocco, and perhaps on the Canary Islands—under the leadership of a certain Hanno, proceeded to explore the Atlantic coast of Africa and deposited, it is said (though there may be an error in transcription or exaggeration) 30,000 colonists on favourable sites.

This expedition of Hanno passed round Cape Verde and eventually reached the mountainous peninsula of Sierra Leone. Beyond this it only proceeded eastwards to what is now the frontier of Liberia, to the region of the Sherbro River. Here on an island (in a region where they still exist in numbers) they noticed extraordinary manlike apes—chimpanzis-and captured some for exhibition at Carthage. But they proved too savage to be tamed. They died, and only their skins stuffed with straw could be exhibited as a great wonder to the Carthaginians. The remarkable exploring voyage to southern England and western Germany of Putheas, the Phokaian Greek of Marseilles, about 350 B.C., has been described by me elsewhere.*

The conquests of Alexander led to a great increase in the knowledge of Western and

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* See "Britain Before History," in Vol. IV. of "The World We Live In" (The Waverley Book Co., Ltd., 7, 8 and 9 Old Bailey, London, E.C.).

The Domestic Life of Primitive Man Revealed

(Photo of the slab presented to the Geological Museum, London, by Messrs. Larlit and H. Christy)

The photograph shows a slab taken from the stalagmitic floor of a cave at Les Eyzies, Dordogne, France, which thousands of years ago was the abode of neolithic man. From the fragments of cave flint and bone instruments, with remains of reindeer, &c.—which time has cemented together, we are able to reconstruct the story of primitive man

Southern Asia on the part of intelligent European peoples. It revealed to the writing and recording world of Eastern Europe the existence of India, of Afghanistan, of Tartary, of Arabia and Syria, and aroused curiosity as to the mystery of the Nile.. But a *good deal of geography about Egypt and Western Asia had already been written down by Herodotos, himself a* native of Halikarnassos, a town on the south coast of Asia Minor.

Romans in Africa

When the Roman Empire was attaining to its greatest extent, expeditions of African exploration were sent out by the Emperors. One of these in 50 B.C. crossed the great snow-crowned Atlas mountains of Morocco and its leader, Suetonius Paulinus, gazed on the Sahara Desert. Another thirty years subsequently a military expedition actually made an attempt to cross the Sahara from Tripoli, and may have got as far south as the country of Kanem. Some twenty years later, at the beginning of the Christian era, another Roman expedition under Julius Matimus even seems—in four months to have travelled from Tripoli to Bornu. The claim may be well founded, as the recorder of the expedition stated that the Romans noticed an abundance of rhinoceroses in this country of "Agisymba," a beast which could not exist in the more desolate parts of the Sahara Desert. A third expedition, instigated by Nero himself, penetrated up the Nile almost to the district of Bor.

Various Roman travellers and writers had revealed the main facts of European geography, excepting the northern Baltic and the coasts of the Arctic Ocean. India was understood, Ceylon likewise, though exaggerated in size, and these Roman writers at the beginning of the Christian era even had some idea of Java, Sumatra, the Malay Peninsula, and of the existence of China.

Their knowledge of Africa had shrunk rather than extended, however. They had heard, no doubt through the negroid tribes and traders in Egypt of the Nile rising from two great lakes more or less at the foot of snow mountains—"the Mountains of the Moon." Roman knowledge, actual or by hearsay, of the east coast of Africa, extended about as far south as Zanzibar. A little was known or remembered about *the Senegal River, but nothing whatever recorded of real West Africa, or West* Central Africa; though a tradition still lingered that Africa was virtually a huge island and had been circumnavigated about 600 years before the Christian era (as we estimate it) by Phœnician ships in the service of a Pharaoh of Egypt.

Unhappily, when Christianity became the established religion of the Roman Empire the Dark Ages began. There were the beginnings, it is true, of a more humane spirit as between man and man; real Christianity never really perished at any one epoch in its long history as a religion. But in the Dark Ages especially between A.D. 500 and 1,000—it was thought to be actually sinful to wish to know anything of the world's geography. Newly-born Islam, however, took up the tale of discovery.

Arab Conquests

The religious fervour of the Arabs, united by the religion of Muhammad, impelled them to enormous journeys to conquer and convert the rest of the world. The success of their armies carried them into the heart of Central Asia, the confines of China, right across Africa to the Atlantic Ocean, down the east coast of Africa to the verge of Zululand and across to Madagascar. They found their way with commerce (if not with conquest yet with religious propaganda) all round the coasts of India and Ceylon, of Burma and the Andaman Islands, of the Malay Peninsula, Sumatra, Java, Borneo, the Moluccas, to the verge of New Guinea.

They had a literature; and their great adventurers, their historians, their poets, or their story-tellers wrote down these marvellous adventures, and sometimes wrote them with surprising accuracy. They had got a shrewd idea of the general course of the Nile, they had discovered Lake Chad, and although they got puzzled over the Niger and the Benue, still on the whole they had formed a fairly correct idea of the geography of Africa north of the Congo basin, and as far south on the east coast as Sofala and Cape Correntes.

The Crusades

At the close of the eleventh century Europe began to awake. The first impulse was a religious one, the desire to recover from the Muhammadan the holy places of Christianity which had fallen into his keeping since the first Saracen attack on the Byzantine Empire. Chiefly from France and from Rome the Crusades were preached, and these Crusades sent squire and knights and yokels from England, men, women, and even children from France, from Aragon, from Germany, Austria, and Italy to the Holy Land. The returning Crusaders, whether they differed or not from the Arabs in religion, were not proof against the fascination of Arab civilisation and learning; and amongst other effects of the Crusades a great interest in geography was aroused in the schools of Italy, France, North-east Spain, the Rhineland, and Southern England.

The Arabs had preserved much of the geographical lore of the ancient Greeks. But even before the Crusades the result of Arab discoveries in Tropical Africa and Southern Asia was becoming known to those who were reviving learning in Italy and France. The Norman conquerors of Sicily and Southern Italy supplanted the Saracens in those directions, and had the wisdom, after the conquest, to conciliate their Muhammadan subjects.

The result was the publication through the schools of Palermo of much information regarding Inner Africa. We may see in the remarkable "Roman de Roland"—an epic poem written probably by an Anglo Norman cleric at the close of the eleventh century—how much new information regarding Moorish and Negro peoples and the Ptolemaic ideas of geography (which had been early assimilated by the Arabs) had penetrated to the minds of Western Europe.

This process of assimilating Arab learning was enhanced by the Crusades and was carried on industriously through the fifteenth and sixteenth centuries by the influence of enlightened Popes; in fact, immense importance was attached to Arabic works on geography until the amazing voyages of the Portuguese, the Spaniards, the English, and the Dutch put such adventures completely in the shade. And noteworthy amongst the great Arab travellers and geographers (and the word Arab must be taken in a very large sense: more often than not these Arabic-speaking Muhammadans were Moors, Tunisians, Egyptians, Persians, or Turkomans) were the following: Masudi and Ibn Haukal in the tenth century; Ibu Batuta of the twelfth century; and Leo Africanus, a Spanish Moor, of the sixteenth century.

Sindbad the Sailor

This intense and growing interest on the part of the Muhammadan world in the geography of strange parts of the earth—an interest vividly portrayed in the tales of Sindbad the Sailor, a work, by the by, which, like Dr. Swift's "Gulliver," was largely based on actual experiences fantastically exaggerated—had stimulated the seamen of Genoa, Venice, Majorca, and of Dieppe, to over-sea discovery and had led to the revelation of the Azores archipelago, the Canary Islands, and possibly some knowledge of the west coast of Africa before the opening of the fifteenth century.

But it had also aroused the attention of the Portuguese, largely through the mind of one man, Prince Henry of Portugal (whose mother had been an English princess of the house of Lancaster). When the Portuguese conquered Ceuta, he gathered from the Moors, in 1415, fascinating accounts of the wealth of West Africa.

IV.—In the Depths: Natural

THE TIGER OF THE DEEP

BY FRANK T. BULLEN

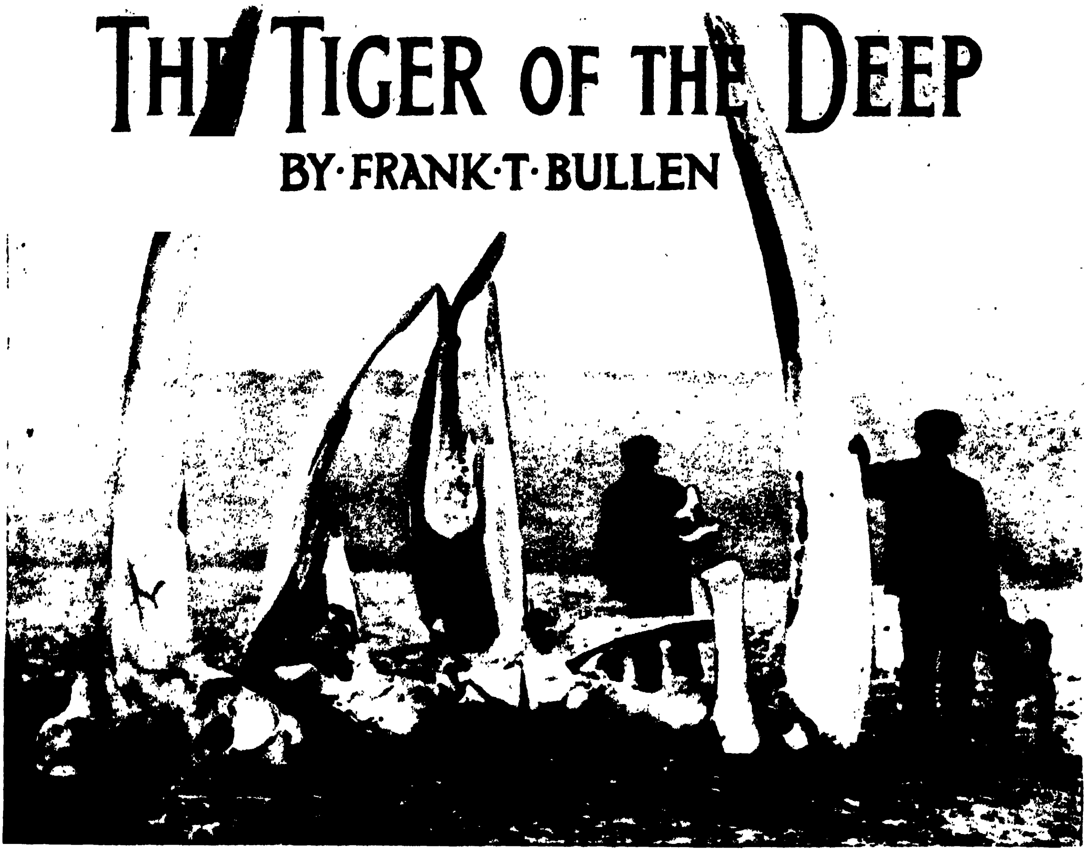


Photo Underwood & Underwood

A Whale's Skeleton

These great bones were found on the African shore near Port Elizabeth

FOR a very long time indeed the kingship of all land animals—after man, of course—has been awarded to the lion.

It is really a little difficult to understand why this should be so in view of the fact that in size, courage, and intelligence he is far surpassed by other creatures of the animal world—the Bengal tiger, for instance, of which it is stated that "its great size, its wonderful activity and strength, its glorious colouring, make it, in many respects, the most striking of all the great carnivora."

When, however, we come to consider the headship of the innumerable tribes of the ocean, we are under no difficulty whatever, and the more we learn about the monarch the less do we doubt his right to the title. True it is, doubtless, that to most people it is sufficient to call the "sea-shouldering whale" the sovereign of the seas, after man, and the idea that among whales there are many varieties does not disturb the placid verdict.

To these folk a whale is a whale, and there's an end on't.

Only naturalists, as a rule, and those who have dared to hunt and slay this gigantic sea-mammal, for the sake of the spoils his vast carcass yields, realise how far in every royal detail ***Physeter macrocephalus***, to give him his full resounding name, towers above every other member of the brute creation. Only in the one factor of size does he yield place to two other kinds of whales, the gigantic Bowhead or Arctic whale, and the vast Rorqual, known to whalemen as the Sulphur Bottom. Both of these occasionally produce specimens half as large again as the greatest Sperm whale ever measured, which was about 70 feet long, 50 feet in largest girth, and weighed in the neighbourhood of 150 tons, or as heavy as twenty-five large elephants.

But the Arctic whale and Rorqual have their only preeminence in size; they are peaceful, unaggressive, stupid, and slow, while they have no weapon for attack or defence save the enormous tail-fin or flukes.

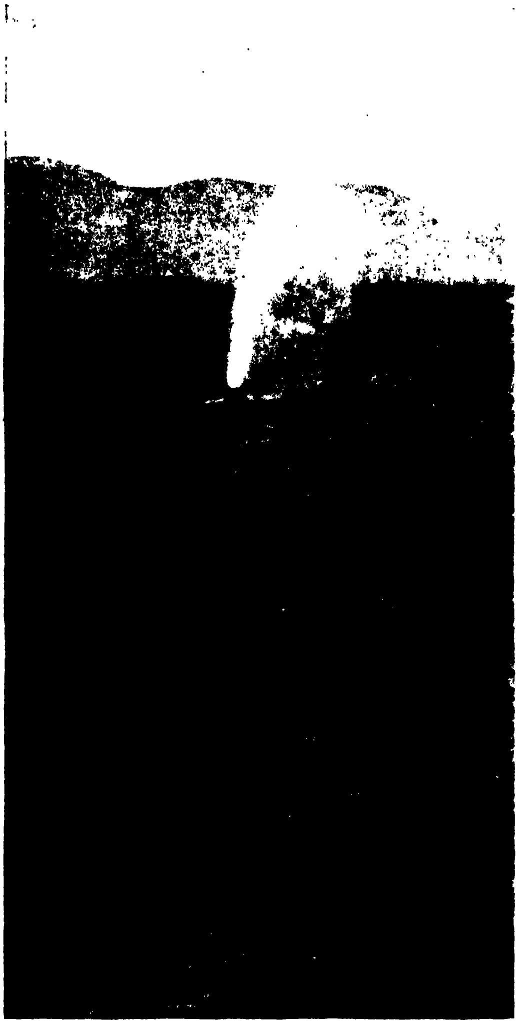


Photo Charles Urban.

"There She Blows!"

The Sperm whale, on the other hand, has all the highest characteristics of a warrior. He is brave and well armed, for his chief feature is his enormous head with its huge, pendent lower jaw, a shaft of bone, often reaching 20 feet in length and bristling with teeth set sparsely on either side of it, and averaging 6 inches in length above the gum. They are conical and about 6 inches in their largest circumference, and fit into sockets in the upper jaw, there being no teeth there to oppose them.

Unlike any other whale known, the female of the Sperm whale is never more than half, more generally one-third, the size of the male. In most other whales the females are the larger. That mysterious substance known as ambergris, even now valued at three guineas per ounce, is produced solely by the Sperm whale. Alone among all whales this wonder carries a great reservoir of liquid spermaceti in his head—pure, bland, snowy, and limpid until exposed to the air, when it concretes. Science has dethroned it from its high place among unguents, for it has no properties not shared by pure lard or vaseline. But think of having 500 to 1,000 gallons of that stuff floating round in a head—not as brains, for the brains of the Sperm whale are not larger than those of a bull. Practically blind, deaf, and without sense of smell, this lordly ocean monarch pursues his amazing way, and thrives beyond belief until he meets man.

These wonderful creatures, alone of all the sea people, have no efficient foes save man and one another. Among themselves Sperm whales fight tremendously for the headship of a "school," and the vanquished ones are thenceforward condemned to roam the wastes of ocean solitary and morose. These "lone whales" are exceedingly dangerous to attack, if indeed they do not attack first, thereby playing havoc with otherwise well-laid plans. But the knowledge of that fierce fact has never deterred the Yankee whale-fighters from attacking them. Indeed, I can hardly imagine any characteristic of a whale that would have hindered an old-time "whaleman" from New England from "sailing in" when prey was in sight.

A Fighting Whale

A monster fighting whale had been twice harpooned and had gone off at top speed for several miles, drawing two boats behind him in his foaming wake. When the great mammal tired, at last with exultant shouts the boats' crews gained upon their prey and drew alongside while the mate hurled a lance its whole length deep into the leviathan's body.

"Starn all! Starn all!" he yelled a moment later.

With a will the men tugged at their oars, and the boats shot clear to avoid a great peril that threatened. From the extreme urgency of the mate's tone they guessed that the whale was about to "breach."

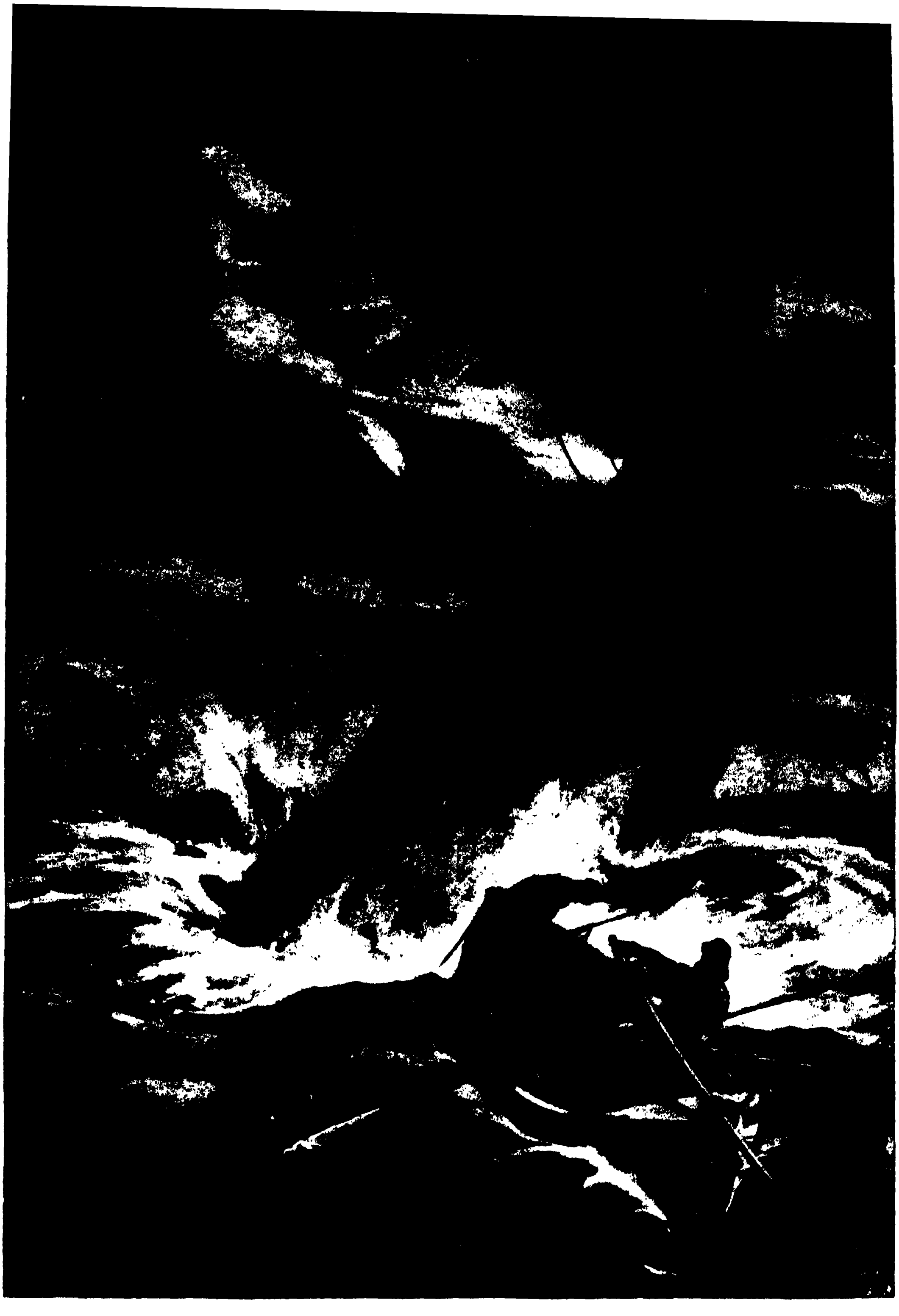
It needs a strong effort of the imagination to picture that dark, solemn sea, only lighted by tiny splashes of phosphorescent light where wavelets broke in obedience to some hidden suasion, or by an occasional, fleeting, brilliant band of light that marked the swift passage of some great fish through the highly charged water. And then, without a sound, like the sudden extrusion of some gigantic flame cone from the uncanny depths, there rose majestically a vast luminous body whose brightness poured from it in floods of light, revealing the black central mass; and, as it soared, the light fell from it in glowing waves to the illuminated whirlpool from whence it arose. At last the leviathan fell, and at the impact a blazing sea rose in many a sudden fountain, an immense boom as of muffled thunder broke the awed stillness of the night, and over a great area wave upon wave of light rushed any whither and broke upon their fellows, until stillness and darkness resumed their momentarily interrupted reign.

For a few minutes the awe-stricken boats' crews sat at their oars unable to think, benumbed, not with fear, but bewilderment at this terrible manifestation of energy. After that brief space the sea-surface gave no sign of anything unusual beneath it, no sound save a faint moaning as of gathering wind afar off broke the cosmic silence of the night. Then a sound like a gigantic sigh broke upon their ears, and they saw, within a short distance, a greenish break in the dark surface of the waters, accompanied by a slight plashing noise as when a lazy breaker lolls upon a reef on a calm day.

But, slight as it was, the appearance roused them to instant energy, and with ready obedience to the hoarse orders given, they wielded their oars, while the boats both headed for the spot. Suddenly the long, slender lance flew from the hands of the foremost boat-leader, and, as if in instant response, both boats whirled about and sped away through the darkness at a speed of some ten miles an hour. It was evident, though, that the enormous effort made by the whale had not been without a certain exhausting effect upon him, for the speed soon slackened.

A Narrow Escape

Then, without a moment's warning, the two boats suddenly rushed at each other, the boat-leaders in each just averting a frightful calamity by snatching up in their arms the two or three lances which were pointing diagonally from each bow. There was a hubbub of voices, a rending and crashing of oars, and the boats shot past each other as the whale, having doubled back upon his previous path, reappeared again with a commotion like heavy waves beating upon a rock. Nearly out of the water, with jaws wide open, he came straight for the boat, intent on biting it in half. The officers were almost frantic



A Fighting Sperm Whale

(Drawn by Arthur Twidle)

These ' lone whales" are exceedingly dangerous to attack, if indeed they do not attack first thereby playing havoc with otherwise well-laid plans

8*

with rage, but the knowledge of the wiliness and power of their foe kept them from losing their self-control. They remembered that, despite the dark and the treacherous element in which they moved, their mobility was to the whale's as three is to one, and that coolness and watchfulness were irresistible weapons.

Photo: H J. Shepstone

A Sperm Whale

Three-quarter front view showing the mouth and under-jaw

There was also this factor—one that is often lost sight of, it is true, but most desirable to remember—that although this monster is capable of stupendous efforts, he soon wearies if he has been wounded ever so slightly. So they bore in upon him vigorously, and again and again the lances flew into the dense blackness, fringed with green light, that marked the position of the whale. Only by the crookedness of the lances, as they hauled them back, could they tell whether they had taken effect or not. Even then they were not sure whether the blow had not fallen upon the head, where no lance can penetrate, which is impervious as a block of solid rubber.

Meanwhile the harpooners at the steer oars never for a moment relaxed their vigilance, swinging the boats this way and that, while ever keeping them "on" the whale if possible. Soon there came a strangled roar, and hoarse triumphant shouts arose of "Stern all, he's in his flurry."

The exertions indulged in previously had so weakened the monarch that the death agony was feeble, and an exultant cheer went up as it became manifest that the great sea beast was dead.

Full Fathom Five

By E. A. BRYANT

WE can travel farther towards the moon than towards the deep abyss of ocean. Men have flown by aeroplane to heights exceeding three miles, and by balloon to suffocation-point, seven miles high. Though the expert diver achieves miracles of heroism, skill, and endurance; yet the utmost depth to which he can descend in the water is 210 feet, and that with every aid that twentieth-century science can devise. Two hundred and ten feet! Reduced to comparative figures, it means that *if* St. Paul's Cathedral were flooded to the cross upon the dome, and the treasures of an Empire lay in the nave, divers from above could not get to within 160 feet of them.

Photo: R. Silk

"Blown Up"

He may shoot like a rocket to the surface, in which case he may break his back

Nature has set us bounds beyond which we may not pass, but we rebel against her prohibition. We storm the heights until oxygen famine chokes us; we tiptoe down a loaded ladder into the deep until the heart almost bursts and breath effervesces into the blood and tissues. And in the scanty depth which means so much—that meagre maximum, 210 feet—lies the scene of some of the most astonishing feats of activity and daring that the world can show. Within that depth of water men lay the foundations of bridges that span the mightiest rivers, and link land with land between which deep seas roll. In that unseen world they blast safe anchorage for the steel leviathans that guard our Empire, and for floating marvels such as the *Olympic*. They rive to atoms wreckage that threatens the safety of a seaway. Within that depth lies the hunting ground of those who dive to gather the pearls that will adorn a diadem or the necklace of a duchess, or to rip the oozy sponge from the rock to which it anchors.

The risks of all divers are the same in regard to that greatest of perils—pressure. But the pearl diver and the man whose quest is sponges may encounter, in addition, more unnerving dangers, for they work in warmer water than the man whose occupation lies in English seas. Shark or octopus, and, in certain latitudes, even poisonous sea snakes, may assail the diver while he struggles for distressful breath. But the primary problem of all is how to breathe or how temporarily to do without breathing.

There are two types of diver—the naked venturer, who fills his lungs and plunges down with his foot in a stirrup of rope to which a heavy boulder is attached; and the man who goes below in a complete diving suit. The latter has nearly 2 cwt. of lead harnessed upon his feet and shoulders; he wears a mighty breastplate which enables him to expand his ribs, and a helmet which is air-receiver, lantern, and telephone combined. The first can descend no lower than 60 or 70 feet, and stays from 90 seconds to two minutes; the second may linger hours at much greater depths.

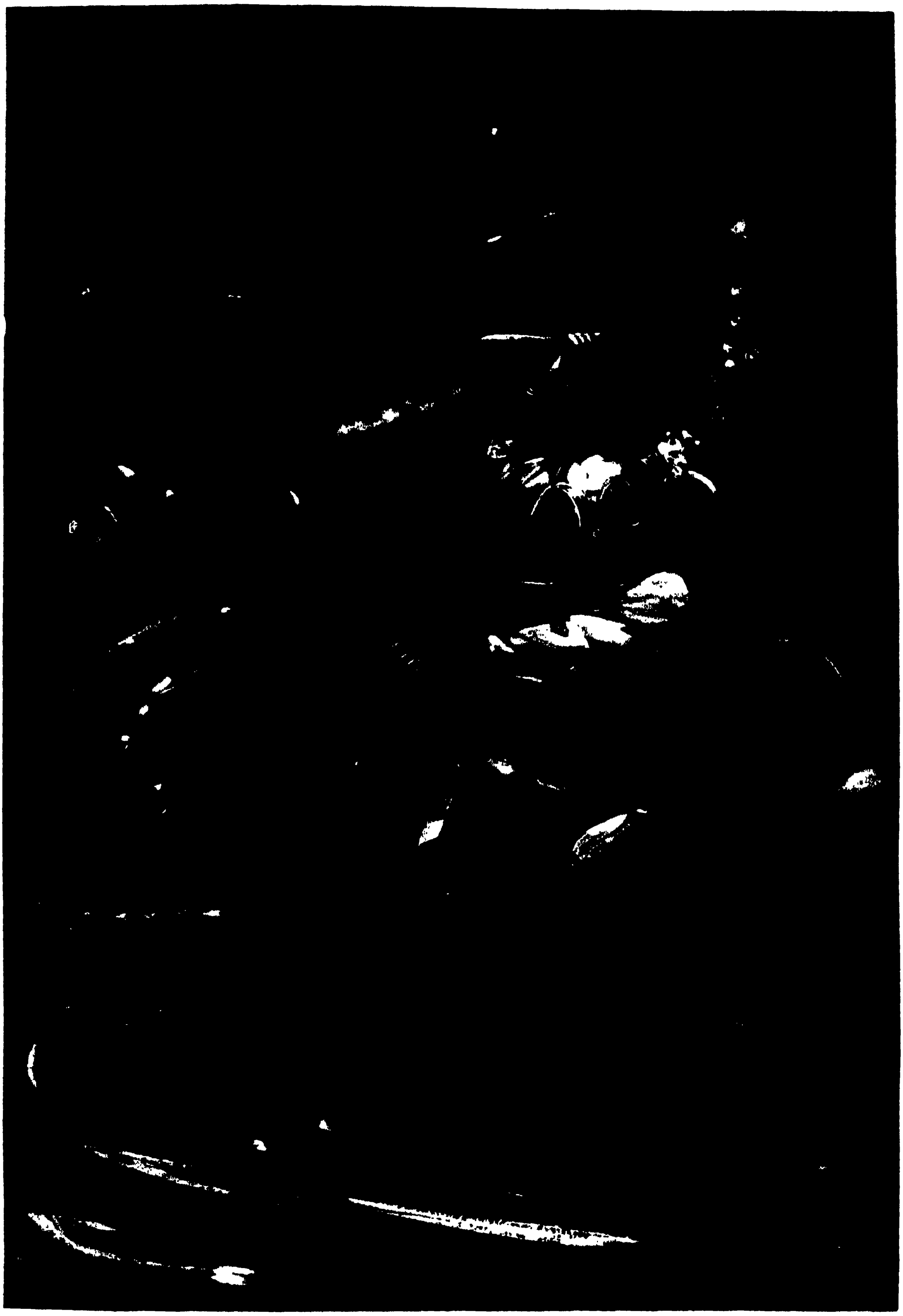
The great fact in the diver's business is this: While he is on *terra firma* he, with the rest of us, endures, without knowledge of the fact, an air-pressure of 15 lb. to every square inch of his body. When he enters the water, every 33 feet that he descends adds an extra atmosphere to the pressure that his frame must endure. The pearl diver who goes down only 66 feet, sustains a pressure of 45 lb. to the square inch. The man who goes to the limit, to the uttermost 210 feet possible, endures a pressure upon his entire body, all told, of 125 tons! The very suggestion would seem to imply that he must be pulped, as have been many of the deep-sea gauging instruments let down for taking soundings. But that does not happen. The human body is 80 per cent. fluid, which is practically incompressible.

Photo supplied by Messrs. Siebe, Gorman & Co.

A dress that requires no air-tubes

The diver in his garb of safety feels nothing of the pressure. The compressed air within his suit equals the pressure of the water. The danger results not from the weight of water, but from the highly compressed air forced down to him. At a depth of 210 feet the pressure of the water is over 100 lb. to the square inch; consequently air at a similar pressure must be pumped down to him. Though the diver may not be conscious of the least discomfort, tragic things are happening. The nitrogen from the air he breathes is forced, under pressure, into the blood, into the tissues, into the spinal column, into the brain. All is well for the time being. The diver has become like a bottle of soda-water, which, absorbing carbonic acid gas under pressure, remains quiescent until the cork is withdrawn, but then the gas is given forth in the form of bubbles. Similarly, when the compression upon the diver is suddenly released, the nitrogen which he has absorbed by way of the lungs—whence it passes, in the blood, in solution, to all parts of the system—this dissolved nitrogen froths off in bubbles. If one of these reach the heart, he drops dead on reaching the surface. If one lodge in the nervous system he becomes paralysed. A collection of bubbles in the joints causes "bends" or diver's palsy. The only way in which he can escape is to make his return from the depths protracted in proportion to the time for which he has been working below, so that the bubbles may return to the lungs and there harmlessly pass into the air respired.

With the greatest care, the explorer of the depths is continually in peril. The tube which conveys the air to him may become entangled, cutting off the supply of life,



The Diver's Dreaded Foe

(Drawn by E. S. Hodgson)

Pulling madly at his life-line to be hauled up, he cut and hacked like a maniac, and the sea-devil fell from him literally in masses or air may be sent down in excessive volume. Again, through his leaden harness shifting, he may be swept off his feet and, with his balance destroyed, shoot like a rocket to the surface of the water, in which case, ten to one, he will break his back; and, as the fallibility of the human factor is an ever-present menace, he fears that his signal may be misinterpreted, that the life-line may be paid out when he is gasping to be drawn up, or hauled in when he is rounding a crag or angle of submerged wreckage. Happily these dangers may be avoided in the most expert diving circles, for in place of the co-operation of thirty-six men needed to pump air down to the 210 feet level, the diver can now carry his own oxygen-making apparatus with him and wear a helmet into which a telephone is fitted, by means of which he can communicate not only with the man on the surface, but, through the boat, with the diver who is working in company with him. Hitherto communication between diver and diver has not been possible, save by the two men standing back to back and shouting, so that sound-waves may vibrate from the valve of one helmet through that of the other—a highly perilous means of speech where the tide is swaying the men to and fro, and apt at any moment to sweep them off their feet on a spine-shattering journey to the surface. But these latest words in equipment are for the favoured few only.

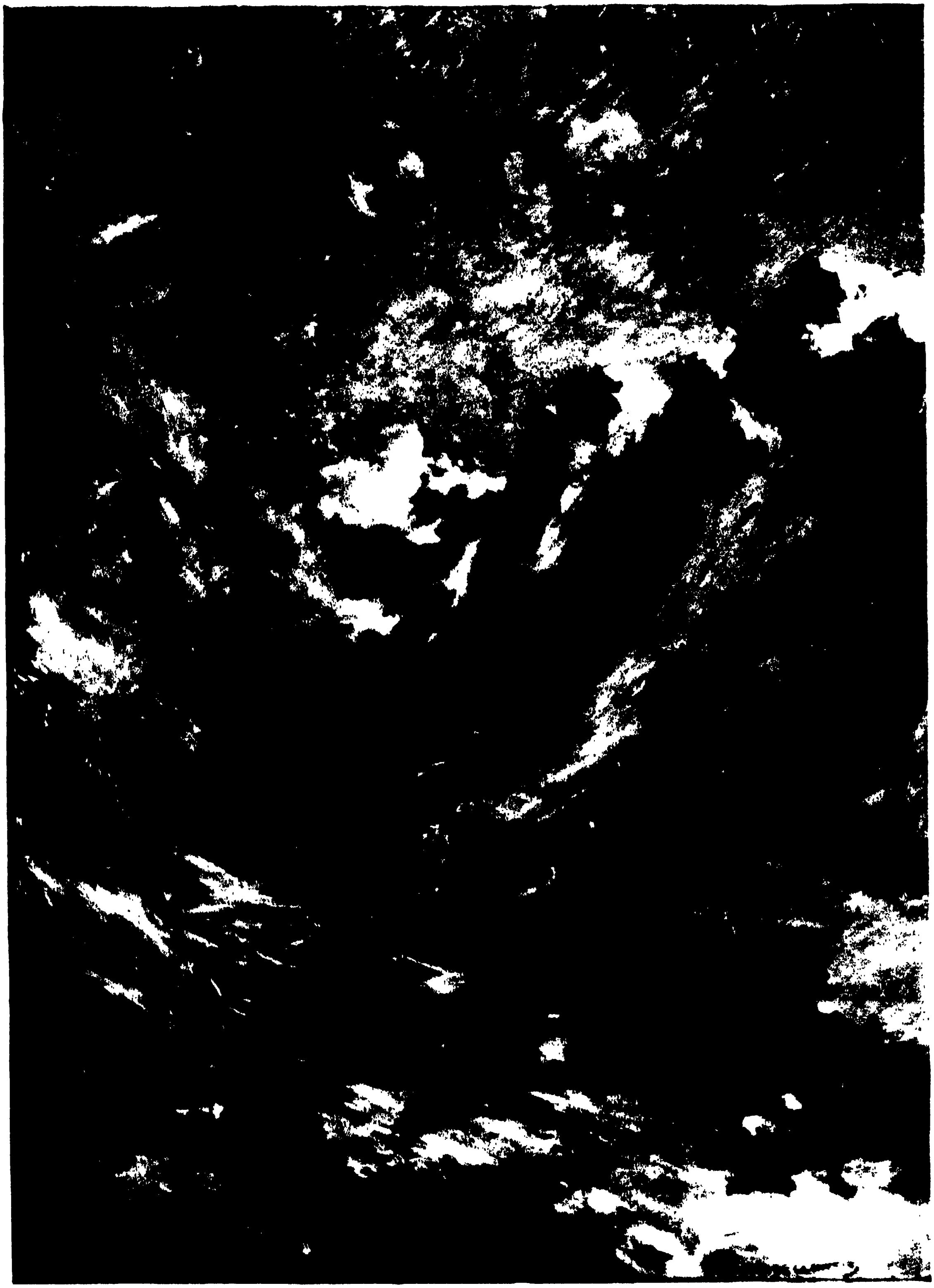
Photo supplied by Messrs. Siebe, Gorman & Co.

A Queer Fish

Caught by a diver when working under water at Durban, Natal

The bulk of the world's work beneath the waters is done by natives who take a deep gulp of air and plunge naked into the deeps, or by those whose diving outfit is still primitive in design and mechanism. These are the men who have the thrills. These are they who plunge down into the warm waters of Ceylon and the Australian coast, to snatch the pearl-bearing oysters, gather them into baskets or other receptacles, and deliver them to the boats upon the skyline of their subaqueous mine. Equally ill-equipped are the sponge fishers, and worse paid. Sharks and other large carnivorous fishes are to be feared by both.

As a rule the shark, which is the hyæna of the waters, is easily scared off by the movement of a human being. It is said that this brute will not attack a man in diving costume, but that is too wide a generalisation from scanty data. Diver Beckett, an old Tees-sider, who is now the chief diver in Australasian waters, nearly lost one of his men from shark-bite. The teeth did not penetrate the flesh, but they rent the man's diving costume to ribbons, and he was all but a dead diver when they brought him to the surface. But the octopus, the devil-fish, as the diver calls him, is the more dreaded foe. Encircled by its frightful arms, each arm equipped with scores of talon-armed sucker-discs, the diver is ordinarily as helpless as a child. The appalling struggle pictured by Victor Hugo has had its counterpart in real life. Peter Snell, a Victorian diver, whose exploit has rendered him famous, was seized by one of these awful creatures when at work deep down in Fairy Bay. Every diver carries a knife handy in his belt. Snell whipped his weapon from its



[illegible] J. Kinston

The Conquest of the Air

From remote ages man longed passionately for this splendid power of flight—to sweep high above the earth, to conquer the full onslaught of the wind, to whirl irresistibly from point to point disdaining the mountains which bar the way of earth-bound folk sheath and slashed for dear life at the engirdling hoops of muscle. Pulling madly at his life-line to be hauled up, he cut and hacked like a maniac, and the sea-devil fell from him literally in masses; but when Snell reached the surface, almost strangled, there still hung about him bands of the brute's arms, which weighed together a quarter of a hundredweight.

Even stranger is the story of Smith, who descended with a keg of gunpowder. A huge octopus menaced him and seized the keg, which was attached to a long rod with an electric wire. Smith was safely drawn up into the boat, where he touched an electric button. There was an upheaval of the water, and the remnants of a giant octopus were blown out of the sea.

The Conquest of the Air

Modern Man's Greatest Triumph

By CLAUDE GRAHAME-WHITE

FAR remote ages, watching enviously the soaring of the birds, man longed passionately for this splendid power of flight—to sweep high above the earth, to conquer the fierce onslaught of the wind, to whirl irresistibly from point to point, disdaining the mountains and forests which bar the way of earth-bound folk. But pitted against this vaunting ambition were grim forces of Nature; and so, for centuries, when he built himself flimsy wings, and leapt rashly from the tops of towers, he was doomed to a fall that was, at the best, inglorious, and, at the worst, fatal.

And yet to-day the miracle has been wrought. Men's brains and hands, forging with infinite labour their chain of deduction and experiment, have given the world at last the wonder it never thought to have—a swift, sure craft which, flying thousands of feet aloft, will bring a journey of days within the span of hours, and pass with equal facility over land or sea.

But does the marvel sink deeply enough into our minds? Do we realise the vast import of this latest and greatest of our conquests? Sometimes, after I have motored to Hendon, and the mechanics are wheeling my biplane from its shed, the thought comes to me that the imagination of the world still lies unkindled by this mighty triumph; and then, a minute or so later, when I am circling skyward through the wine-like freshness of the morning air, I wish that all mankind was behind me in my passenger's seat, seeing with me the panorama of the earth as it is spread forth below, and drinking in, with eye and ear and every sense, the wonder of our conquest of the air.

What is this joy which is so potent that it strikes dumb, for a spell, the man who makes his first flight in an aeroplane? Well, primarily, I think, as its running-wheels spurn the turf, and the aircraft launches itself with vibrationless ease, the sensation is one of sheer exhilaration—a thrill so strong that it sends a catch to the breath and a momentary haze to the eye. This intoxicating sense of triumph—the triumph of the conqueror—dominates all else; and yet, mingling with it, are other emotions, so complex that they elude analysis.

Above all, when one rides this unseen

THE CONQU

In the near future we may expect to see the r

(Drawn by N

THE AIR

r patrolled by a war-fleet of this description

No Fear

element, there is the exhilaration of smooth, seemingly effortless speed: on and on, as the land unrolls below—remote and yet with every detail standing forth—one's aircraft wings its way. Of fear there is no inkling. The engine, droning out 100 horse-power, at 1,000 revolutions a minute, whirls the machine forward without falter or flag. There is a comforting sense of security, even though the earth, a patchwork of dolls' houses and tiny fields, may lie 8,000 feet below—a feeling of ample power, lying in reserve; and, when the wind-gusts strike it, the aeroplane merely rolls like a ship on an easy swell.

And to-day, speeding across country as the crow flies, straight as an arrow from point to point, the airman exceeds the pace of an express train, and can traverse—with an occasional halt to refill his petrol tanks—nearly 1,000 miles between dawn and dusk.

The wind, too, has lost its terror for him. Whereas, but a year or so ago, he was chained to the earth should a stiff breeze blow, he now has the power—through his own increasing skill and the speed and "airworthiness" of his machine—to wage war against three parts of a gale.

In the immensely rapid development of the aeroplane, and in the slower perfection of huge, passenger-carrying airships, is the conquest moving to its final triumph—which will be to link up Europe, and eventually the world, by a network of "airways," each charted and carefully planned as to its route, and each indicated by ground signs during the day, and signal lights at night. Along such airways, at 150 and even 200 miles an hour, is the high-speed transit of nations destined to pass. Thus, in the not-far-distant future, a London business man will deal with his correspondence as usual in the morning, and then take the air-mail to Paris, which he will reach—without changing his seat in the luxury of the flying craft's saloon—in ample time for lunch. Transacting his business during the afternoon, he will catch the return air-service; and this will permit him to regain his London office in time to sign his letters in the evening.

The aeroplane to-day, it is true, is at a stage of constructional development which emphasises, mainly, its potentialities as a weapon of war; but the evolution of metal-built, fast-flying, duplicate-engined craft, will soon show the world the true significance of the aerial conquest.

Flying Boats

Not as an instrument of death, ultimately, but as a revolutionary factor in the world's commerce, will the perfected aircraft play its part. Before the war, the factories, particularly of France, were already making rapid progress; it was in the direction of large passenger hydro-aeroplanes, or "flying boats," that the most striking progress was being made. A machine of this type, for instance, weighing more than two tons, and capable of accommodating six passengers, has already been built and flown; while another even more ambitious, and engined by two motors developing a total of 400 horse-power, is to seat, altogether, a dozen persons.

Vast, indeed, is the difference between big, powerful craft such as these, and the tiny, frail, 25 horse-power monoplane in which Louis Blériot crossed the English Channel, between Les Baraques and the cliffs of Dover, in the summer of 1909; yet it is a few years only since the great pioneer achieved this famous feat.

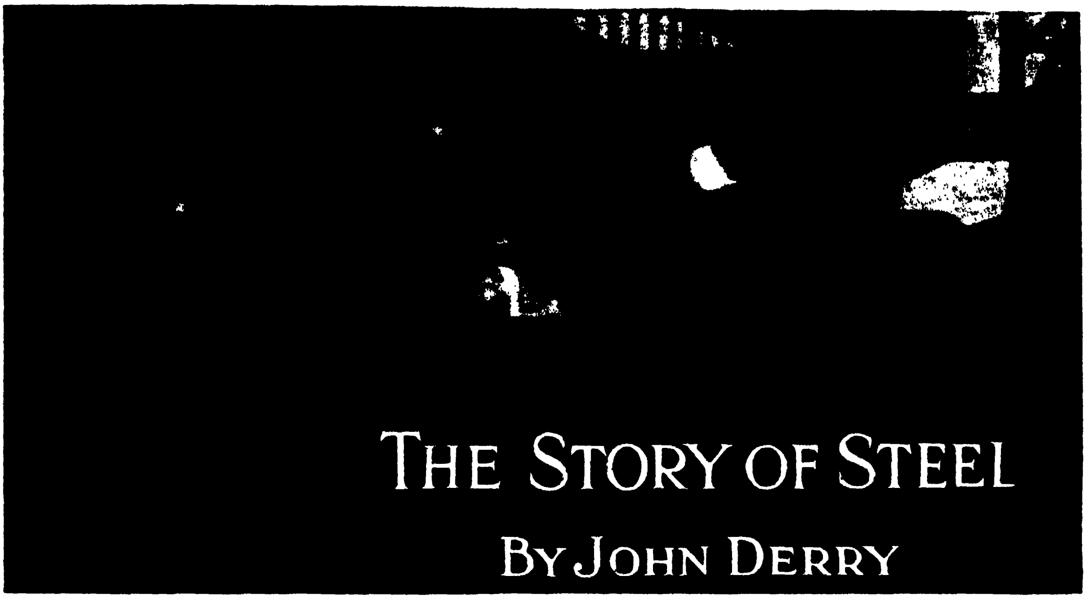
And now—as an illuminating contrast to Blériot's 36-minute flight over 21 miles of water—detailed plans are being made to traverse, by flying boat, the 2,000 miles of ocean which separate Newfoundland and the Irish coast.

So is the conquest made more absolute; and so, stage by stage, will be evolved that commercial, high-speed aircraft which is to alter the world's notion both of distance and of time.

In Full Blast

Bessemer revolutionised steel-making by revolutionising the plant of the furnace. He introduced a current of such intensity that it burnt out the carbon by the combustion of the impurities in the iron ore

V.—Man and Progress: Artificial



THE STORY OF STEEL

BY JOHN DERRY

The Modern Wizard's Cauldron

Wrought-iron is soft, but steel is softer. Cast-iron is hard, but steel is harder

THE story of the discovery of iron and steel begins far beyond the earliest written records of mankind, but the use of steel on a large scale as a material great in bulk and strength, as well as common in use in small ways, is quite new. More than five thousand years ago iron was certainly being used in Egypt, but it only became cheapened for universal service in the form of steel a little over fifty years ago. We are living in the true "iron age," when the industry of all the leading nations is based on steel.

It may be asked whether in thus linking together the iron of the far-off world of Egypt before the Pharaohs and the steel of the days of Queen Victoria we have not been confusing iron and steel. The question was purposely challenged.

The fact is that there is only an elusive chemical difference between iron and steel —wrought-iron, steel, and cast-iron—and nobody has ever satisfactorily defined the difference. The ore in its crude state—the metal iron mixed with various impurities —is iron, and it remains iron when acted on in a preliminary way by fire, with impurities still retained; but when it is further acted on by fire, with the impurities lessened, and the ingredients other than the metal called iron regulated, and, it may be, purposely increased, it becomes steel, and according to the processes through which it is passed takes an infinite variety of qualities.

Steel is as varying in its composition and character as the light of the atmosphere. It changes according to its ingredients, manipulation, and the action on it of heat and cold, in intensity, suddenness, or slowness. Wrought-iron is soft, but steel is softer. Cast-iron is hard, but steel is harder. Where the one passes into the other is undefined. So it is better, in a practical way, to speak of the crude ore as iron, or to keep the name iron for the material uncleansed from its impurities, and to call it steel when it has been brought under control, by chemical action, helped by mechanical manipulation.

Whenever, by accident, iron was discovered, and separated for use, steel must,

The Secret of Steel's Strength

(Drawn by Cyrus Cuneo)

The steels to-day are chiefly iron ores that have been unmade from the natural state in which they were found and remade so as exactly to suit each of a multiplicity of uses

in some degree, have been made, though, of course, in the earlier ages, with simple methods, impurities would abound. The use of fire was certain to disclose the presence of iron, for it is the most abundant of all the metals. The primitive man sheltering his fire with stones, or making himself a dry hearth, would sooner or later select lumps of ironstone. Indeed, he might chance upon a meteorite composed of iron in almost a pure state. The burning log would not only melt the iron in the hearthstone, but the carbon in the wood uniting with the molten iron must form steel of a composition depending on the ingredients left in the metallic liquid. When the melted metal had cooled into a tough, heavy material, the man would readily think of softening it again by heat, shaping it into a desired form, and hardening it by cold.

Primitive Man

Metal, fuel, draught, these were the first requisites of the earliest iron or steel workers. The aim was to procure the purest possible ore, thereby evading the difficulty of burning out impurities. This primitive selection of easily worked material remains important. It is true that furnaces are built now that will extract profitably the metal from an ore which only contains 20 per cent. of iron ; but the purer the original ore—as in the case of Swedish iron—the fewer are the complications which follow. The fine steel work of the Dark Ages—as in the case of the Damascus blade—was a result of the manipulation on a simple hearth of ores of great purity.

For fuel the iron-worker was limited to wood or charcoal till the seventeenth century ; and it was not till the middle of the eighteenth century that smelting with coal or coke became a practical success. The well-wooded districts were therefore originally the seats of the steel trade, and it was the stripping of England of her forests to feed her small smelting furnaces which forced the use of coal as a purifier of iron. Thus the forest of the Weald in Sussex was a busy smelting district, and to this day St. Paul's Cathedral is surrounded by railings cast from Sussex iron. Rockingham Forest, in Northamptonshire, was another centre ; and the ancient steel industry of Sheffield depended originally as much upon its fine forests, in the Don, Rother, Sheaf, Rivelin, and Loxley valleys, as upon its supply of local iron and its abundant water power for grinding wheels.

For draught the hearth-worker of metals no doubt adopted the bellows at an early period—one of the great inventions that has its origin in the unread past. When the furnace was on a larger scale the operator waited on Nature and accepted her help by constructing his smelting hearth at the summit of a ridge facing the prevailing wind. Thus the uprush of all the air from the base to the crest of the hill fanned his fire to a fiercer glow. Throughout South Yorkshire evidences of this device abound. The hills facing the prevailing westerly winds are known as Bole or Bale (Fire) hills.

The modern growth of the steel industry has proceeded on two main lines, both of which had their origin in the Sheffield neighbourhood. First, is the making of high-class, expensive crucible steel for special purposes, such as high-speed tools. The founder of this branch of steel manufacture was Benjamin Huntsman, a Doncaster clockmaker, who turned to the making of steel because he could not find any steel of the quality required for the springs of his clocks and watches. Huntsman purified his steel by application of intense heat in earthen crucibles—a process still practised. The Sheffield cutlers of that day—the middle of the eighteenth century—refused to use the superior steel thus produced until the town began to lose its trade from the competition of French cutlery made with Huntsman's

Modern Growth

Sheffield steel. Then the rival local manufacturers set themselves to discover the secret of Huntsman's success. The first imitator was a manufacturer named Walker, who, dressed as a tramp, gained admission on a cold night to Huntsman's foundry, and, while pretending to sleep by the fire, watched the process of steel-making that, to preserve secrecy, was only carried on at night. Huntsman's firm still exists and prospers, and the kind of steel the watchmaker made, improved into a branch of science, is supplied by a number of Sheffield firms to all the world.

Bessemer

The other main line of development is that of lower-priced steel for use in bulk, as in rails, plating, and constructional work. Here the enormous natural advantages of the United States in producing iron in large quantities has given that country a long lead in the amount of steel manufactured. The originator of cheap steel for use on a vast scale as a common material was Henry Bessemer, who settled in Sheffield and made the steel he had invented because the manufacturers of his day would not make it for him.

Bessemer revolutionised steel-making by revolutionising the blast of the furnace. He introduced a current of such intensity that it burnt out the carbon by the combustion of the impurities in the iron ore. Having disposed of the carbon existing in doubtful quantities, Bessemer introduced fresh carbon of known amount, and thus regulated and controlled the composition of the steel he was making so as to produce softness or hardness at pleasure. The Bessemer process—since modified and improved—brought steel into the market everywhere in place of iron, and remade all the railways of the world.

Bessemer carefully selected the ores he used, as the workers in the earliest times had selected them for their smelting on a small scale. The improvements that have followed since have largely been directed to the neutralisation of impurities in ores, so that the ores with a smaller percentage of iron and a considerable presence of undesirable alloys may be used. The steels of to-day are chiefly iron ores that have been unmade from the natural state in which they were found, and remade to suit exactly a multiplicity of uses, and the goodness or badness of steel depends not upon its percentage of carbon, but its exact adaptability to the precise use to which it is to be put.

Giants

By J. B. STERNDALE-BENNETT

THE giant, as a creature of romance, has long been overthrown. The legendary ogre of superhuman proportions represented as a person of great ferocity, of enormous strength and fiendish cunning, still serves to frighten children in the nursery. The giant of to-day can still pick up a precarious fortune in the booths of fairs; but while science has long since made short work of Gogmagog and his kind, it has also proved that the exhibits shown by impresarios of the abnormal are objects of pity rather than admiration.

Until the beginning of the nineteenth century it was accepted as a fact that races of giants had once inhabited the world. The discovery of enormous bones, purported to be human, substantiated this theory, from which was drawn the obvious conclusion that the human race had degen-

Photo: Underwood & Underwood

Professor Ricalton and Two Cashmere Giants

The giant of 8 feet and over still continues to make his appearance at intervals in different parts of the world

The Giant Myth

erated in size. This belief had come down from classical times, when it was very generally held; in all mythology and folklore this giant myth plays a conspicuous part. This is particularly noticeable in the legends which obscure the true history of old towns. London (with its Gog and Magog), Basle, and Lucerne are only three of the European towns which have their guardian giants. The bones, it may be supposed, which give rise and credence to the myths were those of extinct species of gigantic animals.

It has been proved conclusively that the man of abnormal growth has at all times been a phenomenon, making as inexplicable though less frequent an appearance as his opposite, the dwarf. The causes which govern the appearance of this strange variation from the average human type are still very obscure. From the records of men who have attained a height of between 8 and 9 feet, however, several facts are clear. Far from being possessed of exceptional strength, as is popularly supposed, the giant is usually endowed with a lymphatic temperament, a delicate complexion, weak muscles, a thin voice, a disproportioned frame, a feeble mind, a clumsy carriage, and a short life.

Dr. D. J. Cunningham, Professor of Anatomy at Trinity College, Dublin, who made a very careful study of the skeleton of Cornelius Magrath, preserved in the museum of Trinity College, was of the opinion that this Irish giant, whose height is variously stated, but was probably about 8 feet, suffered from a complaint known as acromegaly, an enlargement of the hands, feet and face. This, he suggests, is a condition usually though not necessarily identified with giants' growth. The trend of scientific opinion has inclined latterly to the belief that giantism is a diseased condition, and this is strongly supported by the fact that most giants die young. Cornelius Magrath, who was exhibited both in England and abroad and attracted a great deal of attention in scientific circles, died at the age of twenty-three. As a boy of fifteen he was advertised to be 7 ft. 8 in. Charles Byrne (8 ft. 2 in.), another Irish giant, whose skeleton may be seen in the Museum of the Royal College of Surgeons, Lincoln's Inn Fields, died at the age of twenty-two. Few giants have lived longer.

The literature of known giants of modern times is unsatisfactory and independable, owing to the temptation, which few chroniclers seem able to resist, of exaggerating the size of their heroes. Chang, the Chinese giant, who was exhibited in London in 1905, is known to have been 8 ft. A Scottish giant, who served in Frederick the Great's regiment of Guards, is said to have been 8 ft. 3 in. An Austrian, Josef Wintselmain (1865–87), is said to have attained the height of 8 ft. 9 in. Loushkin, the Russian, is represented as 8 ft. 5 in.

Tall Races

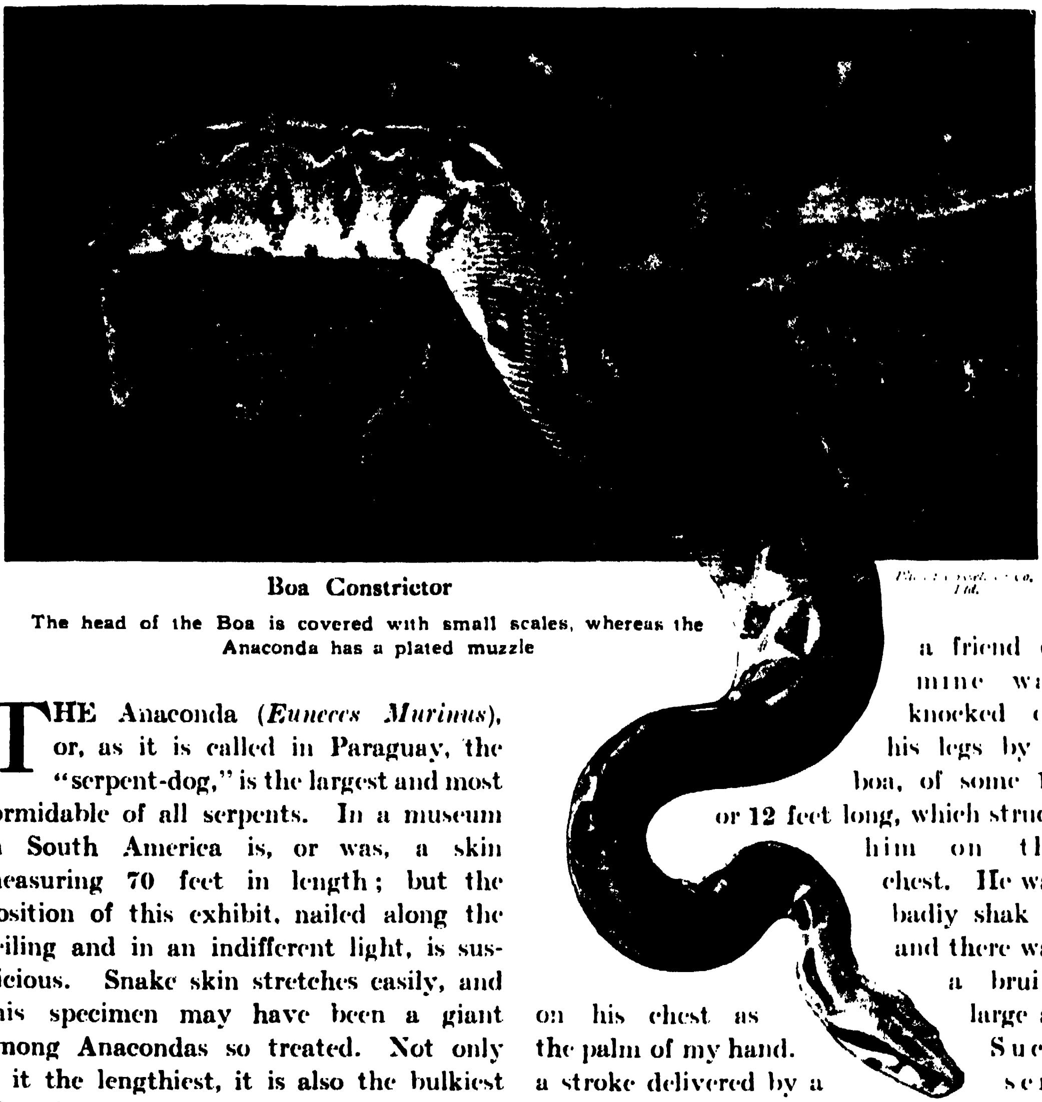
Though the ancient theory that giant races existed is long since exploded, it is necessary to note that some races attain a greater average height than our own. The Patagonians, who have been described by early and impressionable explorers as being of enormous size, have an average height of 5 ft. 11 in. A few years ago an explorer, travelling overland from Cairo to Johannesburg, reported that he had discovered in German territory an aboriginal colony of negroid people the male members of which were mostly over 6 feet in height.

The causes governing this variation from the average height of the human race are not yet definitely ascertained, but so far no difference has been discovered incapable of scientific explanation on the lines indicated above. The giant of eight feet and over continues to make his appearance at intervals in different parts of the world, but he is always the abnormality and the rarity, and has therefore little significance and no bearing on racial characteristics.

The Serpent Dog

The Largest and Most Formidable of Serpents

By CLAUDE E. BENSON



Boa Constrictor

The head of the Boa is covered with small scales, whereas the Anaconda has a plated muzzle

Ph[illegible] Co., Ltd.

THE Anaconda (*Eunectes Murinus*), or, as it is called in Paraguay, the "serpent-dog," is the largest and most formidable of all serpents. In a museum in South America is, or was, a skin measuring 70 feet in length; but the position of this exhibit, nailed along the ceiling and in an indifferent light, is suspicious. Snake skin stretches easily, and this specimen may have been a giant among Anacondas so treated. Not only is it the lengthiest, it is also the bulkiest of snakes. A 12-foot Anaconda will equal in girth a python half as long again.

The attack of such monsters is a terrible thing in its mildest form. Very often a constrictor will content itself with striking with its snout. To give some idea of the violence of the blow I may say a friend o mine was knocked off his legs by a boa, of some 10 or 12 feet long, which struck him on the chest. He was badly shak and there was a brui on his chest as large as the palm of my hand. Such a stroke delivered by a serpent of thrice the length, bulk, and strength would have been instantly fatal.

In addition to this fighting power, the Anaconda has its mouth furnished with six rows of sharp, recurved teeth, four on the upper and two on the lower jaw. Now, when a snake opens its mouth it does not

The Serpent Dog

(Drawn by Arthur Twidle)

The Mboy-yagua (serpent-dog), of Paraguay, will upset canoes. The Indians have an intense horror of this terrifying creature do so after the fashion of men and beasts. It bisects its entire skull to behind the ears, and yawns till its jaws are at right angles to its neck. Then it strikes. The impact of such an armament directed by such a force is terrific.

A Tragic Performance

To crown all, the Anaconda is a constrictor. Many years ago now I remember an instance of a man who was performing with a 17-foot python at a circus in Spain. For some reason or other the creature got frightened and contracted itself. At the time it happened to be round the man's body. The man fell at once. At first the spectators imagined it was part of the performance, but after a while the truth was recognised. Medical examination showed that the man's bones were broken in eighty-two different places. That was the work of a relatively small serpent.

The rapidity of the attack of a constrictor is such that the eye cannot follow it. It is probable that the victim is dead before it knows what has hurt it. Certainly death by being run over by a motor-car is not more swift. I have seen a duck swimming quietly, and all at once it disappeared simultaneously with a slight splash and an uncanny crackling of bones. These creatures also attack human beings. I know of two bad scares, one in the case of a man who dived into the water right on to the top of an Anaconda, which, fortunately for him, fled in terror; the other of a girl who was seized whilst paddling. Fortunately, the monster missed her body, but secured her bathing-dress, so that the scene in the Garden, with Eve in her original costume, was partially reproduced. Only Eve was not dallying with the serpent.

As Dr. E. Bourgade la Dardye points out in his book on Paraguay, though it may not be hard to avoid a boa on land, " it is a much more serious thing to be exposed to the attacks of the huge water-serpents of the Murina tribe, known in the country as the *Mboy-yagua* (Serpent-dog). They will upset canoes, and drag bathers down into the water. The Indians have an intense horror of them. During my exploration of the Ygatimi I saw one cross the river a little way ahead of our boat, and I am confident it was not much under ten yards in length."

With all its power of jaw an Anaconda could not bite off a limb. It could, however, strip the flesh as one peals a banana.

There used to be travellers' tales of these gigantic snakes killing and gorging oxen, leaving the horns, which they could not swallow, outside the mouth till they dropped off. Again, more recently, we hear of one attacking and upsetting a boat. These stories have been received with scepticism. So was du Chaillu's account of the Pygmies. There is no reason why they should not be true.

Coloration

Albeit not a python—a race confined to the Old World—the Anaconda is not a true boa. It differs notably in having a plated muzzle, whereas the head of the boa is covered with small scales. Unlike most constrictors, its colouring is not attractive—a sort of greenish-grey, with large black spots on the back and lighter eye-like spots on the side. It spends much of its time in the water, but it frequently takes to the trees. It is found in the tropical forests of Eastern South America, and is very plentiful in Guiana (where it is known as the Kamudi), and in Brazil and Paraguay. The popular English name is Water Boa.

I.—On the Land: Natural

VOLCANOES – I

BY ARTHUR HOLMES, F.G.S., A.R.C.S.

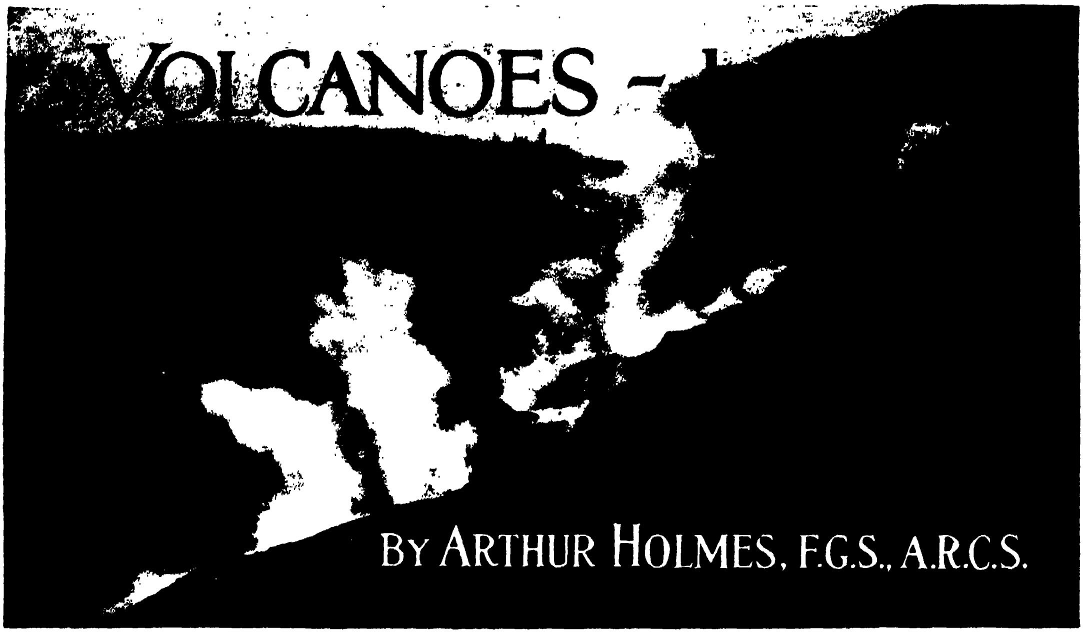


Photo by Jas. Johnston, M.D.

The new crater on the side of Souffriere belching forth black smoke and boiling mud

VOLCANOES stand out supremely as monuments of the most awe-inspiring and terrifying of terrestrial activities, while at the same time they illustrate with no lack of spectacular display the external phase of the most fundamental of the processes whereby the evolution of our globe has been accomplished. Volcanoes have been called the earth's safety-valves. They are more than that; they are the earth's breathing pores. Without them our planet would be suffocated by its own excess of energy, the unending accumulation of which would ultimately lead to a catastrophe of such widespread and explosive violence that the face of the earth would be annihilated in a blaze of cosmic ruin.

The question arises whether it may not be just this fear which first suggested the grim conception of the nether world, with its tortures of fire and brimstone. Even to-day there are unenlightened souls who regard the terrible forces of vulcanism as active agents of punishment and destruction in the hands of an angry Deity. In a kindlier spirit we may see in volcanoes not a warning of the wrath to come, not a foretaste of the fiery convulsions in which our globe will perish, but a guarantee of safety and stability, of life renewed and sustained. Indeed, from this point of view some philosophers have sought to prove that much of our current theology is an inheritance from an ancient race, which deified volcanic lava. For them the foundations of the earth were laid by lava and its plutonic equivalents, and they saw in vulcanism not a symbol of their own destruction, but a promise of life and a source of wealth. Living through the closing phases of the Great Ice Age, they were encompassed by the icy coils of the glacier dragon, the most formidable enemy of mankind. Then came forth, from the depths, the central fire of God, making war on the ice-clad serpent and driving it back from the abode of men.

Leaving these fascinating speculations, let us turn to the volcanoes themselves and learn what we can of their jealously guarded secrets. Many of the earlier school books—

Photo: W. F. Hartley

Neptune's Cauldron

The photo shows the immense cloud of steam arising from where the lava from the volcano on the Island of Savaii, in the Samoan Group, meets the sea.

those well-meaning but ineffectual manuals of the mid-Victorian era—defined a volcano as "a burning mountain emitting fire and smoke." Such a definition bears as much relation to the true function of a volcano as does a smouldering fuse to the gunpowder magazine whose latent energies it will presently arouse. Our modern conception of a volcano is that of a rift in the crust of the earth from which hot gases and vapours, ashes, and finally molten rocks are explosively vomited. The ejected materials generally build up a lofty mountain mass crowned by a central cone, which is truncated by a bowl-shaped crater. This feature, however, is by no means essential, for vast masses of lava may be poured over the land without a trace of cone formation.

Photo: T. C. Hepworth

A Burnt-out Volcano

The crater of an old volcano in Poolvash Bay, Isle of Man

At the present day mountain building or "central" volcanoes, such as *Stromboli* and *Vesuvius*, are developed almost to the exclusion of any other type, but it would be misleading to suppose that they constitute the most distinctive emblem of volcanic action. If we transfer our attention from living volcanoes to the dissected bodies of certain of their ancient predecessors, we find that at various times in the earth's history "fissure" eruptions have occurred. Long, open rents took the place of the more familiar funnel-shaped craters, and from them enormous floods of basalt welled out over the surrounding country.

The greatest eruption of modern times was of this type and occurred at *Laki* in the south of Iceland during the summer of 1783. For several days severe earthquakes warned the inhabitants of the district of the devastation which was swiftly to follow. The eruption commenced in June with the opening of a vast fissure, over twenty miles in length. From this appalling chasm burst forth torrents of gleaming lava, accompanied by immense clouds of suffocating vapours and incessant crashes of thunder. The lava floods sent long, fiery arms racing headlong down the valleys and overwhelming them in ruin. The rivers were boiled away, and their place was taken by streams of molten rock which ultimately filled up to the brim the glens and ravines and overflowed the meadows and woods of the open country on either side. The first destructive outbreak was reinforced by fresh eruptions again and again throughout the summer of that ill-fated year.

Only a few people were killed directly, but hundreds were ruined, and thousands died in the following year owing to the famine and pestilence which followed. The total amount of material ejected from the crater of *Vesuvius* during historic times sinks into insignificance beside the mighty streams of basaltic lava which issued from the fissure of *Laki* within a few weeks. Four or five cubic *miles* of rock were poured over the country, sufficient to have petrified the whole of London in a stony winding sheet 50 feet in thickness.

Prodigious Outpourings

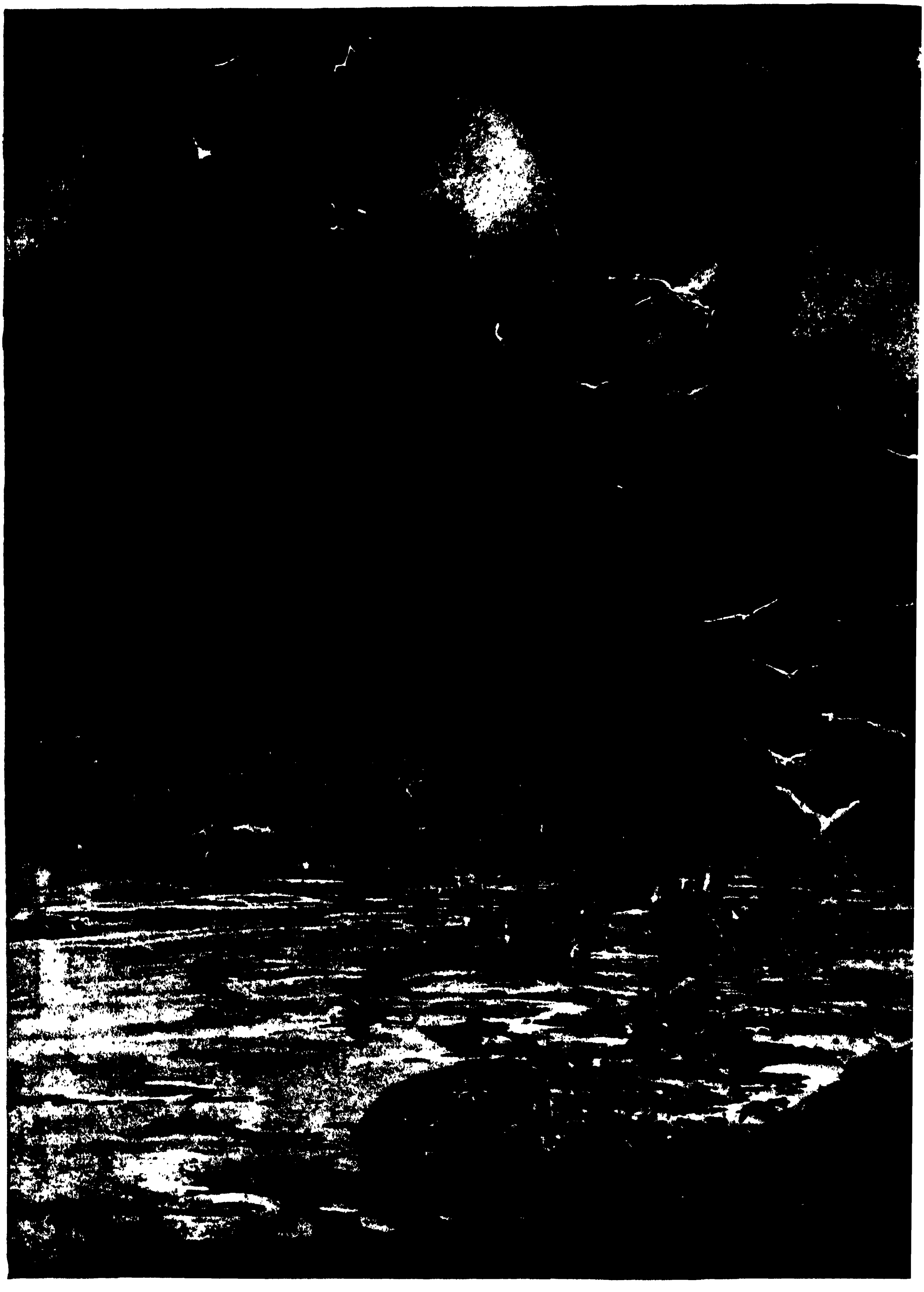
In the Western States of America there were in Tertiary times prodigious outpourings which buried 200,000 square miles of country beneath a vast series of lava sheets often exceeding half a mile in their aggregate thickness. In our own islands, the *Giant's Causeway* and *Fingal's Cave* are well-known relics of a similar basaltic plateau which extended from Ireland far into the Arctic Circle. Although the eruption of *Laki* may seem trivial in its results compared with these gigantic outbreaks, it must be remembered that in the one case we are dealing with a single summer's activity and in the other with the accumulated floods of perhaps millions of years.

Turning now to the more familiar "central" volcanoes, we shall find that they fully compensate for any lack in the massiveness of their products by the vigour and spectacular effect of their operations. Whereas fissure eruptions are characterised by the fluidity of the molten lava and the consequent ease with which the accompanying gases and vapours are expelled, the most significant feature of the central eruption lies in the predominance of the explosive element. Unable to escape readily from the more viscous lavas, the imprisoned gases in an irresistible fury of pent-up energy give rise to violent explosions, pulverising the rock and producing bombs and lapilli, and clouds of finely powdered ashes, all of which are ejected high into the atmosphere in the wild upward rush of the suddenly liberated gases.

The most stupendous volcanic explosion on record was that which in 1883 altered the map of the Straits of Sunda. In prehistoric times there existed between Java and Sumatra a gigantic crater of which *Krakatoa* and its neighbours are the wrecked and shattered relics. The volcano had been dormant for two centuries previous to its impressive awakening in 1883. In that year, after a long series of earthquakes had shaken the island, a passing warship observed a preliminary eruption, in which clouds of vapour, heavily charged with dust and pumice, were shot up to a height of seven miles. At the same time dull booming sounds were heard at Batavia, a hundred miles away. Excursion parties were organised, and in happy ignorance of the great catastrophe which was soon to follow, a number of enthusiasts climbed to the very edge of the crater. Fortunately the volcano was timely in its warnings. For weeks it continued its intermittent eruptions, gradually increasing in violence, until the final paroxysm took place in the last week of August.

Krakatoa

On the 26th, a thick cloud of black vapour rose above the island to a height of seventeen miles, and by the next morning the pall of ashes had spread to Batavia. Rain, transformed into mud by its load of dust, fell incessantly, and the town was plunged into darkness of an awful intensity, relieved only by vivid flashes of lightning. Then, at 10 o'clock on the morning of the 27th, came four explosions of the most appalling magnitude, one of which could be heard 3,000 miles away. When next the island was seen, two-thirds of it had been completely blown away. Eight square miles of land had been replaced by eight square miles of sea, which in places reached a depth of 1,000 feet. Old lavas and new were blown to dust, enormous quantities of which were discharged into the upper regions of the atmosphere. The sea was covered for miles by the falling débris of pumice and ashes; fresh islands were created, and old ones were enlarged. The finer particles of the dust cloud were distributed far and wide,



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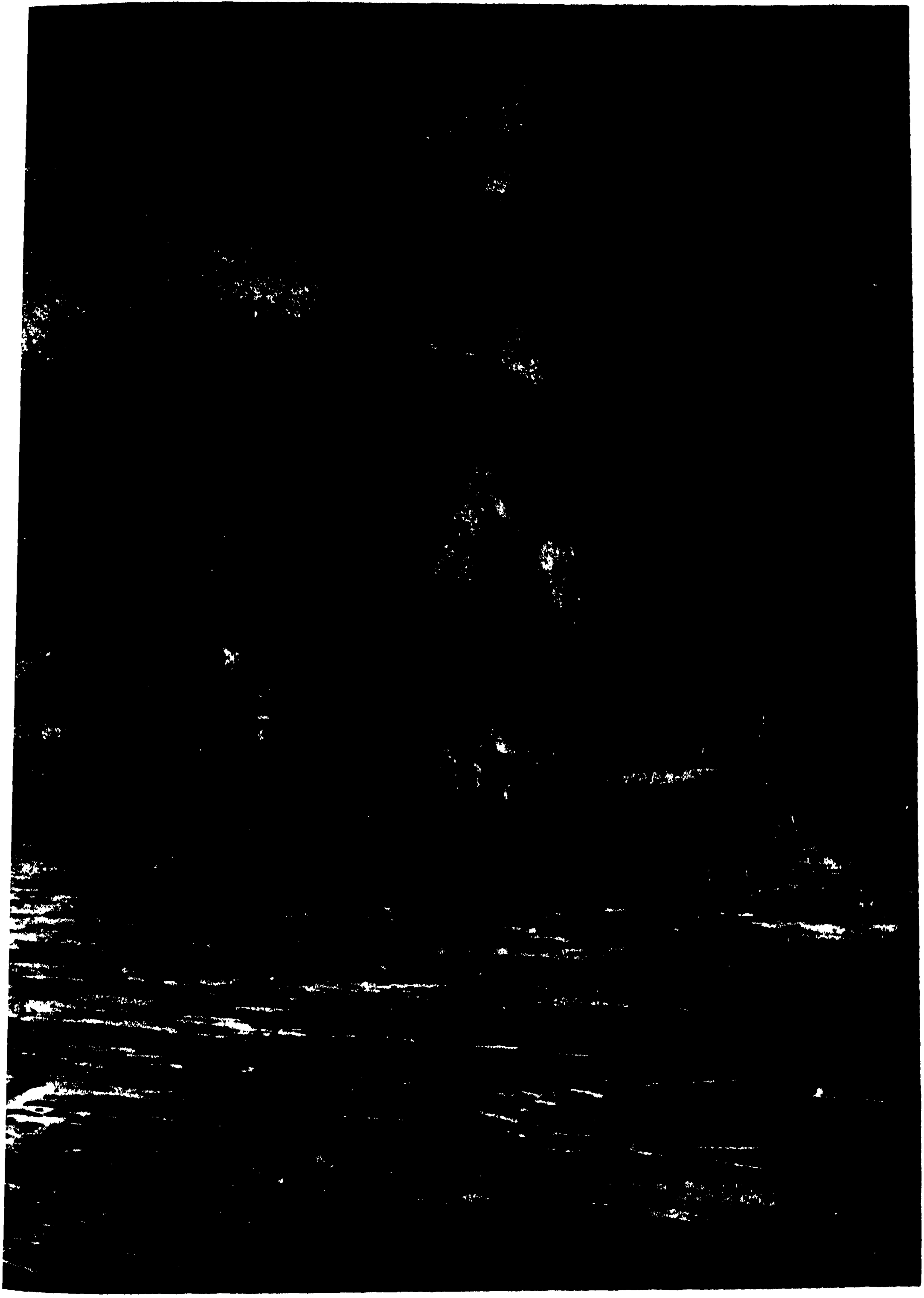
(Drawn

A volcanic avalanche swept over the flourishing city of St. Pierre and killed its



ONT PELEE

ings Wright)

abitants. **St. Pierre was utterly annihilated, a city of the dead, shrouded in a pall of ashes** by air currents, until at last they accomplished the circuit of the globe. As the dust spread over the sky, extraordinarily brilliant sunsets and vivid afterglows were seen, and a dusky, reddish ring was observed around the sun. In all parts of the world these striking phenomena became visible towards the close of the year, and they continued to excite wonder and interest throughout the two following years.

Although *Krakatoa* was uninhabited at the time of its colossal upheaval, the catastrophe did not forego its toll of life. Vapours burst through the sea-floor, earthquakes heaved up the waters, and huge waves were engendered—mighty banks of water, nearly 100 feet high, which rose over the low coasts of Java and Sumatra, devastating the shores and destroying about 40,000 people. So great was the irresistible sweep of these immense sea waves that a warship was carried inland and left stranded three miles from the coast and 30 feet above high tide mark. The waves rolled over the oceans until they were detected even in our English Channel.

To-day there remains of *Krakatoa* only a few reefs and a precipitous relic of the original cone, an astounding change, which is indeed a mighty tribute to the plutonic energies of our planet.

Where the Lava Meets the Sea

One August night in 1905 a volcano suddenly rose from a peaceful cocoa plantation in the Samoan group of islands. Its flow of lava, in some places 700 feet in depth, proceeded to fill up the sea along a frontage of seven miles. For more than a mile out to sea the ocean boiled

One of the most awful accompaniments of an eruption, and the most pitiless in its toll of life, is the hot, incandescent blast, such as that which destroyed St. Pierre in the island of Martinique. No serious disturbance had alarmed the inhabitants throughout the nineteenth century, although *Mont Pelée* had occasionally indulged in slight explosive outbreaks and wreathed itself in suffocating, sulphurous fumes. But with the incoming of the present century premonitory earthquakes became frequent, so severe as to break the submarine cables to Guadeloupe and Dominique.

Portents of Disaster

Portents of coming disaster appeared in the clouds of vapour which curled up the mountain side, and in the evil-smelling gases which reached St. Pierre. Towards the end of April in 1902 a rapid series of alarming detonations began, and a high column of vapour and ashes rose above the mountain and gradually extended until fine dust fell all over the island and darkness crept ominously towards the ill-fated town. A frightful and incessant storm of rain and ashes began. Earthquakes persisted and grew steadily worse, and a continuous roar of explosion and thunder reverberated around the mountain. Finally, on May 8th, a great incandescent cloud, intensely hot and thickly charged with ashes and stones, was ejected from *Pelée*. Unfortunately the crater was choked by the viscous lava of the eruption, and the blast, instead of expending itself less harmfully in the atmosphere, found a more destructive course, curled over, and rolled *down* the mountain to the sea. St. Pierre lay in its course, and in a few minutes the volcanic avalanche swept over the flourishing city, and rapidly killed its 30,000 inhabitants. Red-hot ashes and blocks of lava rained down relentlessly, completing by fire whatever the suffocating fumes had left undone. It was thought *Pelée* had done its worst, but in August the volcano excelled all its earlier efforts in a climax of terrible violence which left the island a grey, desolate waste. St. Pierre was utterly annihilated, a city of the dead shrouded in a pall of ashes.

Then began the most remarkable feature of the eruption. The crater of the volcano was found to be filled with a seething mass of spurting, viscous lava. In November the lava rose up like a dome, and from it there was protruded from below a long spine or tongue.

This most curious plug of lava solidified on the outside as it grew, and was thrust upwards at the rate of 30 feet a day until, after a career of alternate collapse and rejuvenation, it ultimately towered 1,500 feet above the crater floor. It proved, however, to be a short-lived erection, and it gradually broke away until in a few months it became merely a stump surrounded by its own ruins.

The Largest Building Stone in the World

IN the neighbourhood of Baalbec, the City of the Sun, known to the Greeks as Heliopolis, there still exists a quarry from which the skilled engineers of the remote past delved the giant monoliths used in the construction of the Great Temple and the Temple of the Sun, the ruins of which yet remain, though the ancient city is now but an insignificant village, with a few hundred inhabitants.

How the ponderous stones, of which the temples were built, were raised to their positions is a problem which has puzzled engineers as much as savants and antiquarians. The most plausible solution suggested is that a sloping embankment of

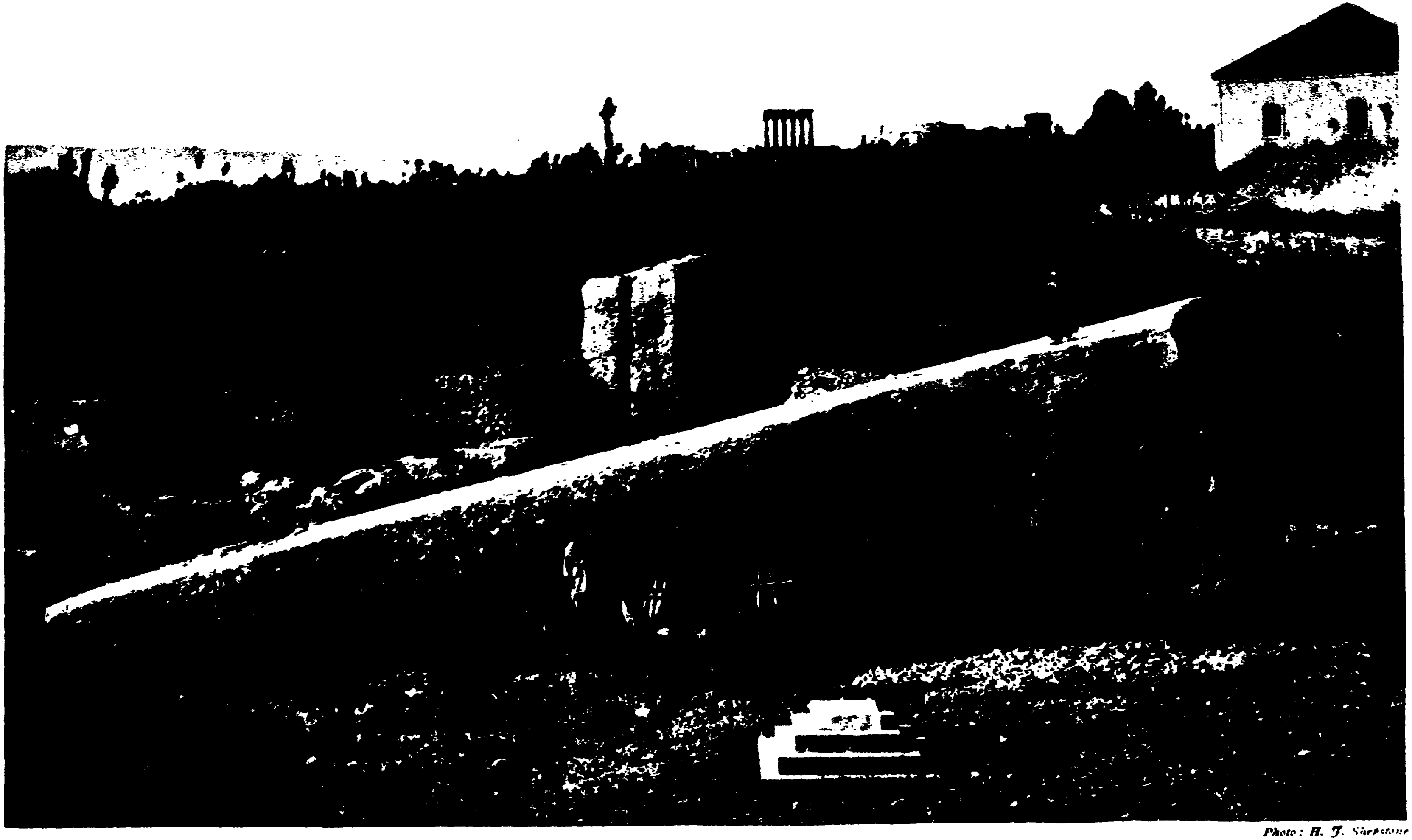


Photo: H. J. Shepstone

The Largest Building Stone in the World

In the ancient quarry, a quarter of a mile distant from the ruins of Baalbec, is still to be seen a gigantic monolith—the largest in the world—shaped but not detached from its native rock. It measures 70 feet in length, 13 feet in width and is 14 feet high. It weighs 1,100 tons

earth was built from the quarry, a quarter of a mile distant, and the stones drawn on rollers by thousands of slaves, the method resorted to by the Pharaohs of Egypt when they raised their pyramids. The enormous mounds of earth still to be seen in the Great Court give colour to this theory.

The largest stone of all lies in the ancient near-by quarry, never having been detached from the rock beneath. This one is 70 feet long, 14 feet high, and 13 feet wide. Its estimated weight is 1,100 tons, and it is computed that to raise it would require the strength of 6,000 men. It is called by the natives "*hajar el-hublâ.*" It was probably intended to be placed in the wall of the temple enclosure; but some sudden war, pestilence, or revolution must have interrupted the plans of those ancient builders, or they would not have expended the labour of years upon this mighty block, and then abandoned it still undetached from the quarry.

Bottomless Pits

The Exploration of Earth's Deepest Chasms

By E. A. BAKER, M.A., D.Lit.

IT has more than once been my privilege to be the first, or among the very first, to reach the lowest depth in one of those huge chasms or pot-holes which had always been reputed bottomless, and, as a bygone philosopher put it, in direct communication with "The Abyss."

On the limestone mountains south of Lough Erne, near Enniskillen, in a region of caves and underground waters, a yawning hole called in the native Irish "Sumera" has been from legendary times invested with all the terrors of an entrance to the infernal world. Opening suddenly amidst upland pastures, it is still, in spite of every precaution, a continual danger to cattle, and even to the inhabitants. At the present day the most familiar name is Noon's Hole—a legacy from a horrible incident of the troubles with the Ribbonmen nearly a century ago. Noon turned informer, and, being found out, was decoyed to this spot by his associates and flung into the pot-hole. His body lodged on a shelf, and was eventually recovered; but from 1826 till 1895, the place was avoided.

Half-blinded by Spray

In that year, M. Martel, the veteran explorer who gave such an impetus to the science of caves in England as well as abroad, attempted a descent. He reached a point about 70 feet down, and being half-blinded by the spray from the waterfall, thought that the masses of rock which he saw beneath him were the bottom, and that the stream ran away through small sink-holes. In 1907 a party of English and Irish explorers made another attempt, taking the precaution to dam back the stream. Passing the spot reached by M. Martel, the present writer scrambled down from the end of a rope-ladder to the rock masses previously mentioned, and found that they were really a sort of natural bridge, beyond which the chasm went on vertically into the darkness. The ladder was let down farther, and the writer ultimately reached a second rock-bridge, 148 feet from the surface; but there was not sufficient tackle to proceed farther.

Just six months ago the attempt was resumed. Again I had the privilege of

Photo Underwood & Underwood

Weathercote Cave

This photo admirably illustrates the manner in which streams plunge sheer down into the bowels of the earth

pioneering a way into the unknown. Three men had descended to the second bridge, and sent a rope ladder on into the black pit beneath. It was like being inside a gigantic water-pipe. Showers of water pattered down from aloft; it was pitch dark, and all seemed vacancy below, even a powerful motor-lamp failing to give the least indication how near to or how far one was from the bottom. Then, almost at the last rung, I stepped off on to something solid; I had reached the bottom of Noon's Hole at 250 feet from the surface. One of my comrades joined me, but we were unable to get far along the passage traversed by the stream, for the water came nearly to the roof.

Some of the English and Continental pot-holes have had their reputation for appalling dimensions reduced to much less than 250 feet. Ten years ago the Kyndwr Club descended the famous Bottomless Pit in the Speedwell Mine, in Derbyshire. Far in the interior of a lofty hill, a hundred years ago, a lead-mining company spent a fortune in driving a level, which broke into a vast, empty cavity, running up into the 650 feet of limestone overhead, and downwards into a black abyss. Upwards the cavity is a tremendous thing; nobody has ever seen any vestige of a roof. The lower part, which was christened the Bottomless Pit and at once enrolled among the wonders of the Peak, is much less exciting. The waters from the flooded level pour over with a frightful sound, and powerful searchlights serve only to light up abysmal darkness. But about 40 feet down we alighted on a slope of rocks which led to a pool, and when we had built a raft and taken soundings all over this Stygian lake, the utmost depth we could attain was 22 feet. There were no signs whatever of a hole going through to the centre of the earth!

Elden Hole is a dry pot-hole five miles away. Now we find that Charles Cotton, the friend of Izaak Walton, states that he sent a sounding-line 884 yards down here without reaching bottom. The notorious Dudley, Earl of Leicester, too, is recorded by the philosopher Hobbes to have hired a peasant to descend the hole, and the poor man was hauled up in convulsions—

> "The soul's citadel
> Was stormed or taken by the imps of hell."

The peasant died in eight days, and never revealed what awful realms he had penetrated. Yet here we reached finality 265 feet below the cave-mouth, the first vertical drop being 180 feet. Several narrow escapes occurred during its exploration. Either Elden Hole has altered considerably since those days, or some of our documentary records are anything but reliable.

With other spelæologists I have spent several fruitless days among the deserted mines of Somerset trying to find the Gulf, into which, it is related in the county histories, a man was let down by the miners on a long rope, and found himself at the extremity swinging in space, and unable to discover top, sides, or bottom. It is hinted that this may have been one of the Hutchinsonian swallet-holes, which carried off the waters of the Deluge and put out the central fire believed in by Plutonian geologists.

Throughout the limestone districts of the world there are similar openings, and the instance of the Chourun-Martin, to be dealt with later, shows that there is no need for semi-scientific or other legends to make them impressive to the feeblest imagination. Some of those that look most innocent and insignificant are among the most formidable; and, on the other hand, many that are grandiose of aspect and seem to hint at incredible depths are comparatively shallow. Thus the enormous openings of the famous Padirac and the Tindoul de la Vayssière in France, are only about 100 feet deep, though it is true they are the natural gateways to a world of subterranean marvels. There are much deeper holes in England which you

Photo: C. Hastings

Gaping Ghyll Chamber

This photo was taken with immense difficulty, 340 feet below ground. Observe the stream which falls sheer from the ground above

Photo: C. Hastings

Five Hundred Feet Below Ground

The subterranean stream from Gaping Ghyll journeying through Ingleborough Cave on its way towards the daylight can jump across with hardly an effort; and across one, Long Kin West, on Ingleborough, a beaten track goes by a little rock bridge, which you can bestride with your legs dangling, and on either hand a clear drop of 320 feet. The pot-hole of Jean Nouveau, explored by M. Martel, is not a whit more imposing, yet it descends sheer for 500 feet; and the dangerous abyss of Vigne Close, some 80 feet deeper, is only a few feet in diameter at the top.

Photo: C. Hastings

Alum or Helln Pot

One sees the waterfall above tumbling, as it were, out of the sky and losing itself below in the misty depths where other falls roar down

One of the deepest avens, as they are called in France, is that of Rabanel, which reaches a depth of 640 feet with an initial drop of 500 feet perpendicular. More tremendous still are the pot-holes in the limestone district of the Karst, on the borders of Istria and Carniola. Two in particular, which have quite insignificant mouths, measure respectively 770 feet and 970 feet in vertical depth. Going south through Montenegro, we find ourselves in a country pitted with caves and abysses, and in Greece the Katavothra, though not so deep as their terror-striking portals suggest, lead into a vast series of subterranean halls linked together by titanic corridors.

A detailed account of the English pot-holes would fill a large volume. They abound on the limestone slopes of the Pennine, but the largest multitude are on three adjoining hills, Ingleborough, Peny-ghent, and Gragreth. I should like to describe Rowten Pot, on Gragreth, which is 365 feet deep, and Mere Ghyll, on Ingleborough, with its huge reservoir, containing sometimes 70 feet of water, held up in the heart of the limestone. But there is room left for only the briefest accounts of two of the most famous on Ingleborough, Gaping Ghyll and Alum or Helln Pot. The name of the latter is said to hint at a direct connection with Hades.

From the higher slopes of Ingleborough a charming beck flows down to the limestone level, about 1,000 feet above the sea, and at Gaping Ghyll disappears, with one leap of 364 feet sheer, into the mountain. Descents have been made several times by means of rope-ladders—a very trying ordeal, and much time, hard labour and risk are saved by the use of a windlass. Seated in a bosun's chair, one is let down by the windlass in a few seconds, the return journey taking, however, from seven to ten minutes. I don't know which is the finer sensation. One notes such scenery as would have given ideas to Dante himself —the darkness of the pit below, into which the beetling crags that wall the mighty shaft seem to plunge headlong, crags soaring overhead into an unearthly daylight, and the water falling in front of you and around like a torrent of foaming light. At the bottom is a chamber 479 feet long, and 110 feet high, where there is room enough to build a cathedral, and beyond this a mile of intricate passages have been explored.

Helln Pot

Helln Pot, 300 feet deep, is different, but not less impressive. Without rope-ladder or windlass, one may reach a rocky platform, a third of the way down, by following the course of an underground water-channel; and from this point one sees the waterfall above tumbling, as it were, out of the sky, and losing itself below in the misty depths, where other falls are roaring down to the final pool. The rest of the descent is a serious climb. Three hundred feet down we pass beneath a lofty arch, and come, at the end of a dungeon-like vault, to a deep swirling pool, with no visible outlet.,

The subsequent course of this water has been accurately traced by means of colouring matter. It flows down and under Ribblesdale, the river valley between Ingleborough and Penyghent, and passing under the Ribble itself comes up in the bed of a tarn on the farther side. Helln Pot must have existed, much as it is now, before the great Ice Age. When that passed away, thousands of years ago, vast heaps of debris were left behind, filling the bottom of the river valley, and burying the ancient waterway. That is now a subterranean tunnel; and far overhead the Ribble has carved for itself a new channel through the accumulation of glacial debris. But the river and the cave stream do not mingle their waters until, as in a gigantic siphon, the stream is forced up into the tarn by the pressure of the column of water in distant Helln Pot; the overflow runs gently into the Ribble

Underground Agriculture

How Subterranean Chalk Quarries and Even Catacombs have been Made to Yield Rich Harvests

AMONG the many curious methods of making an honest penny devised by ingenious people, the plan of turning the catacombs under Paris to account for mushroom growing surely takes high place. History does not record the name of the genius who first discovered that there, and in abandoned chalk quarries, were to be found in conjunction precisely the most favourable conditions of temperature and humidity for the development of *cryptogams*. It appears, however, that a gardener named Chambry conceived the plan about a century ago of laying out mushroom beds in abandoned subterranean chalk quarries. To-day the principle has been so far extended that there are hundreds of miles of underground beds in cultivation. It would astonish the sculptors of the Middle Ages, who sought special varieties of stone for the adornment of Paris, if they could revisit their abandoned quarries to-day. They have been joined up until they form a maze-like labyrinth teeming with human moles, who cannot traverse their " gardens " without bending low their heads.

A visit to one of these subterranean farms is full of interest. The post, furnished with rungs, which we see inside the ventilating chimney, provides access to the

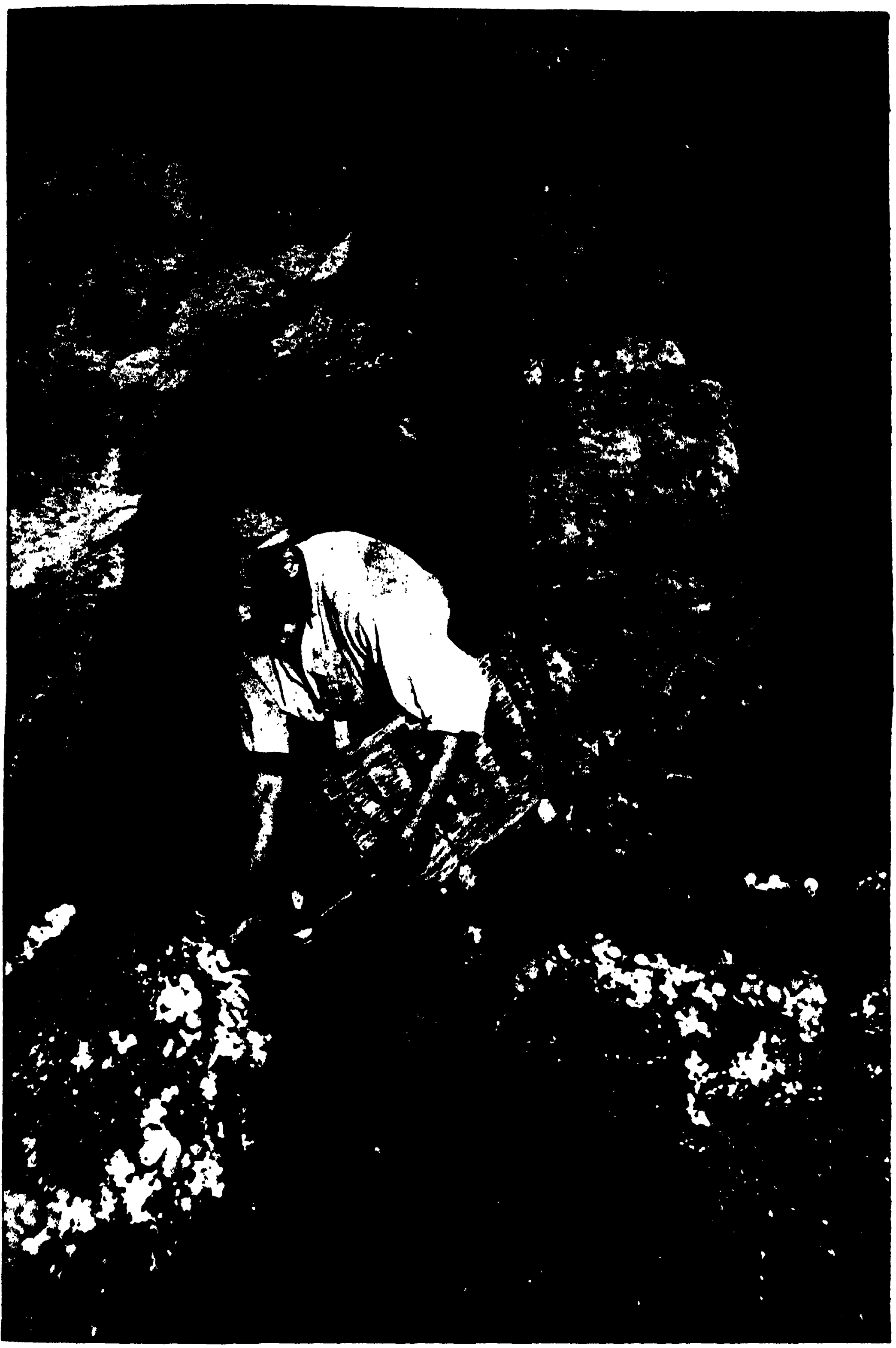


Photo: J. Boyer, Paris

Market Gardening in the Underworld

In the Department of the Seine, France, 80 proprietors possess 250 underground mushroom-growing establishments, wherein 1,000 employees labour

Photo: J. Boyer, Paris

A Pampered Crop

The growers carefully maintain conditions of warmth and ventilation which many a human being might envy. Observe the post with rungs by which the workers descend the chimney

curious grotto, of which the walls are sometimes a-glitter as if with gems. Looking along the narrow passages, one sees the scintillating rays of the lamps placed at intervals to guide the workmen; the latter, like their crops, are pale from lack of sunlight, and the enervating atmosphere.

The art of the mushroom grower consists very largely in adapting local conditions so as to render them exactly suited to the requirements of this very delicate crop. The principal difficulty arises from the enormous quantity of oxygen which the "breathing" of the mushrooms absorbs. When they are deprived of their full supply of air, their growth is arrested. It is, consequently, necessary to ventilate the galleries thoroughly, and keep the air saturated with vapour throughout their entire length, as well as to take precautions against fluctuations of temperature. The work is skilled, and requires incessant care, but the rewards are proportionate, as the number of those who find it profitable to engage in the industry testifies.

In the department of the Seine alone, there are 250 of these mushroom-growing establishments, belonging to eighty proprietors. The number of workers employed in this curious form of labour is more than 1,000.

So skilfully is the industry organised that there is seldom a slack season. The various galleries bear their crops in rotation. It is no uncommon thing for one proprietor to send up a ton or more of mushrooms in a single day. The annual value of the Parisian mushroom crop, exported all over Europe, exceeds £500,000.

In addition to their use for mushroom culture, the caves are employed by French and Belgian market gardeners for the purpose of bleaching other vegetables, or to produce them out of season. The cultivation of wild chicory provides one of the most interesting examples of this method. Although chicory grows spontaneously almost anywhere, few people

Photo V. Roger, Paris

A Typical "Field"

On an underground market garden the various galleries are made to bear their crops in rotation. The annual value of the Parisian mushroom crop exceeds £500,000

would care for it as a salad if it were not cultivated so as to modify the bitterness of its tight and hairy dark green leaves. The frugal Parisians long since found means to employ this vegetable and endive in the salads they love so well. Both are transformed in character by careful cultivation in the caverns of the netherworld.

The Mystery of the Waterspout

The Natural History of an Ocean Terror

By N. F. WATSON

THE demi-god of savage tribes in waterless lands is that painted impostor, the rainmaker, the wizard who, to some extent weather-wise, summons from the clouds the rain which he brilliantly guesses is about to fall. The demon at whose appearance the boldest mariner trembles is the rain-maker of the heavens, the much misjudged waterspout. It is questionable which is the more misunderstood—the sable citizen of the backwoods who gains his living by pretending to make rain, or the actual thing which swallows up ships and crews by making rain which it is not understood to create. They that go down to the sea in ships have told us often and again how, out of the cyclone, has sprung a whirling devil-cloud which has sucked the waters of the ocean up to the very heavens and imperilled every craft within its sphere of operations. Well, the sailorman is a lovable, credulous creature, and we must forgive his misinterpretation of natural phenomena, and write down his definition of waterspouts in the book which holds his tales of ribbon-fishes become sea-serpents, of basking whales converted into the progeny of the monstrous Kraken.

But it is surprising that scientists should misinform us, too. Yet there is one naturalist of note who tells us of the terror of the sailor when "the waterspout *rises* in fantastic shape;" and witness the observations of another most charming and ordinarily dependable writer, who assures us that "waterspouts are formed by two winds blowing in opposite directions, and raising or sucking up the water in their vortex."

Descending Column

Think for an instant what the effects of this would be. A ship caught by a waterspout would be flung heavenward by the ascending current of water. Gravitation would recall it to its proper element, but its career to destruction would begin with an upward flight. A ship in an ascending waterspout would be in very much the condition of the egg-shell tossed up by the jet of water in a shooting gallery. Now, the men who survive waterspouts are not many, but those who do, without reasoning from cause to effect, have reason to remember that the attack develops, not from below keel, but from overhead. True, they may find themselves enveloped in an aerial maelstrom of sea-spume, but that is only a secondary and minor effect of the phenomenon; the funnelled column of water, half a mile, it may be, in height, which sends battleship or ocean tramp to her doom, links the clouds and the ocean by a torrential descending column.

The waterspout rides in the whirlwind, though it does not direct the storm. It is the child of the sunlight; but Alpine snows and tinkling brooks of cosy valleys, the waters of the heavier ocean, the breath of placid lake and murmuring stream, the ice of the Arctic, the dew upon the rose's damask cheek, are all among its ancestors. It is the wayward, benevolent slave of man which, upon an unpredicted saturnalia, manifests itself as his most terrible enemy. It has been hot as steam, low down at the equator; it has been, when seven miles high at the same spot, cold as the icy breath that slew Captain Scott and his heroic comrades. It has drifted like a shuddering blast across the unmarked grave of Franklin, it has murmured through the trees surrounding the little clearing in whose midst stands the modest hut where Livingstone passed to meet his Master. For the malevolent, all-destructive waterspout is but the vapour in the air, raised by the sun from avalanche and torrent, from the lofty brow of snow-capped mountain, from the steaming marshes of the equator. Wherever there is snow or ice or water, evaporation is constantly at work, replenishing the atmosphere, and it depends on local conditions whether the moisture shall come back to earth, drop by drop, bestriding as a charger the impalpable dust far-flung from a Krakatoa or Vesuvius, the sand particles whirled over distant seas from deserts in which valiant explorers have laid their bones to bleach, or the insoluble atoms belched skyward from London's myriad chimneys. Every raindrop has its courser or its chariot; there is a speck of dust at the heart of every globule of water that patters back to earth. And of such stuff as rain is, so, too, is the waterspout. The composition of both is identical; only the method of delivery is different.

What Happens

What actually happens, then? We say, and are wrong in saying, that the waterspout is evolved by the cyclone. The waterspout is the outward and visible manifestation of purely local atmospheric disturbances. Its immediate progenitor is the whirlwind, whose path is bounded by parallel lines from a few yards to a few miles apart, but with an average breadth of about a quarter of a mile. The cyclone may cover an area three thousand miles in breadth. One such has been traced from Japan, out over the Pacific, across America, over the Atlantic and Europe, to lose itself in the wilds of Siberia, there to chant a fitting requiem for Russian exiles, dead of broken hearts. The waterspout, as we have seen, is local, occurring over seas and

A Ship Caught by a Waterspout

(Drawn by Norman Wilkinson)

lakes, and even large rivers, alone, or in the company of several other waterspouts, all within defined limits. The waterspout will sink the stoutest ship, by force of impact and volume of flooding water, but a cyclone which lives up to its traditions, will exert the force of nearly 500 million horses, and, travelling at forty miles an hour, will employ for its ravages air 100 miles in diameter, and a mile high, which air, though we borrow its name as the symbol of lightness, weighs, in the aggregate, as much as 150,000 ships of 10,000 tons apiece. Compared with force such as this the waterspout, child of the whirlwind, is but a trickle of water through a pinhole as against the volume cast by the mightiest steam pump.

Musical Chairs

Even so, it is formidable enough. And yet it arises from what seems the most simple and innocent of origins. Near the surface of water lies a stratum of moist warm air. To this is carried a colder current. The colder air, being heavier, sinks, causing a rapid upward rush of the warmer air. It is the whole air-circulatory system in miniature. The air, warmed at the equator, rises, expands, and drifts to the Poles; the colder air from the Poles rushes in to take its place, and so the process goes on. But with our waterspout the area of "musical chairs," as we may call it, is limited. The heated air of the lower atmospheric strata rushes upward, leaving a greatly lessened pressure. Immediately air from all sides crowds in upon the centre. With such a scramble of converging currents not all can reach the centre. Some are deflected from the straight line and are caused to gyrate. They must reach the centre or its immediate vicinity, for they cannot go beyond, where the pressure is high. They miss the target as it were, but still seek to turn to the middle position vacated by the ascending column of air. And so in the twisting and writhing of commingling battling currents we have a sort of atmospheric joy-wheel. In the rapid whirling thus set up, the air is for the most part driven outward from the centre into a funnel-shaped column. Within this the remaining air becomes highly rarefied and cold; its temperature descends below dew-point, and it must then precipitate its moisture. The clouds, no longer supported by high atmospheric pressure, dip rapidly downward and rest upon the swirling column. They themselves are in reality an agglomeration of tiny particles of water, and the moisture of clouds and that of the spinning hollow cone of air combine.

Then we see the waterspout assume its characteristic funnel shape, hanging with its apex downwards. The water condensed from the cooling air and that from the clouds as well, descends like a veritable Niagara, in an unbroken torrent, from clouds to sea. The ocean is violently disturbed by the battle overhead, and is caused to toss and foam. In that condition it contributes its frothy spray to the whole, drawn up to a small extent by the suction overhead, but influenced also to a great extent by the downpour, which calls forth a great volume of reciprocal splashes. But the deluge which makes the mariner's heart faint within him is not the innocuous splashes of spray, it is that overwhelming deluge from the skies. That which a few moments before was balmy air has been transmuted by the inimitable alchemy of Nature into a perpendicular torrent which may sink a Dreadnought.

Sweet Waters

It is in the tropical seas that waterspouts are most to be feared, for it is there that storms most succeed to calms; there that still airs are most heated by evaporation of the sun-bathed waters. But in whatever latitude it appears, the waterspout is the offspring of sun and snow and sea and river, and when it descends its waters are sweet as the sea is salt. This confutes the theory of the mariner and his dupes who tell us that the waterspout is sucked up from the ocean.

Photo: H. J. Shepstone

How One of the World's Most Ancient Monuments was Sailed from Egypt to London

THE most fascinating and challenging object of its kind in London is that which no one goes to see. Cleopatra's Needle, with five and thirty centuries of history, stands upon the Thames Embankment. Electric tramcars, taxicabs, motor-cars, and dustcarts thunder past the live-long day, and pedestrians hurry on, heedless of the magic links by which that silent fingerpost to history associates them with the Greatest of Stories. Cleopatra's Needle was hewn and fashioned fifteen hundred years before Cæsar's galleons first sighted Britain. It had grown venerable with years and history when England was yet the home of savage cave-dwellers, when London was a swamp, when the pillars of Stonehenge were still unquarried.

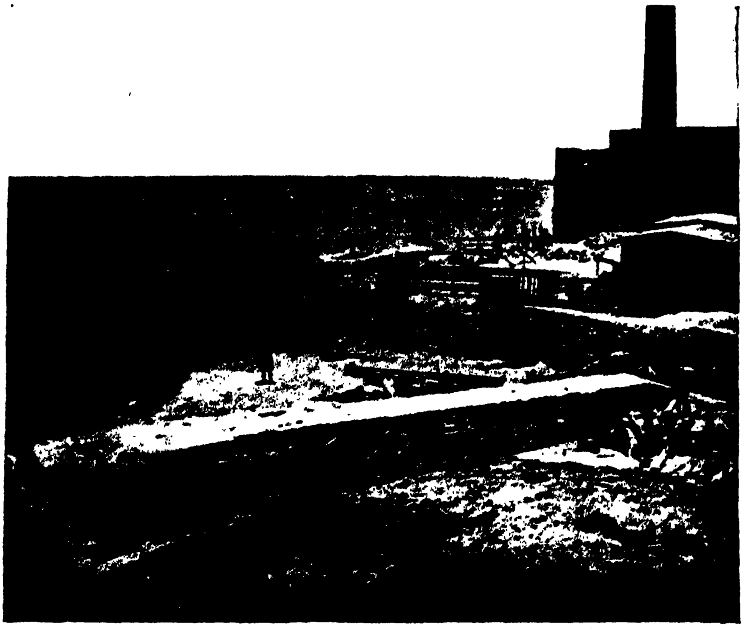


Photo. H. J. Shepstone.

Cleopatra's Needle as it fell at Alexandria

This pathetic relic of the skill and glories of a dead age was carved to commemorate Thothmes III., king of Egypt, who reigned ages before the Greeks had emerged from barbarism. It was set up at the great king's capital, which is known now to us by the

Greek name of Heliopolis, City of the Sun. Torn from the red granite quarries of Syene, it was transported, 68 feet in length and weighing 140 tons, 700 miles to the sacred city, hauled, by sweating slaves, upon wooden rollers running on greased platforms of timber, to the river, floated down the Nile when the stream was in flood, then drawn again by human beasts of burden to the court of the king, and set up to glorify his deeds and titles, and also to reverence the sun-god that the regal idolater adored. And later Rameses the Great carved his own style and story upon the second of its four faces.

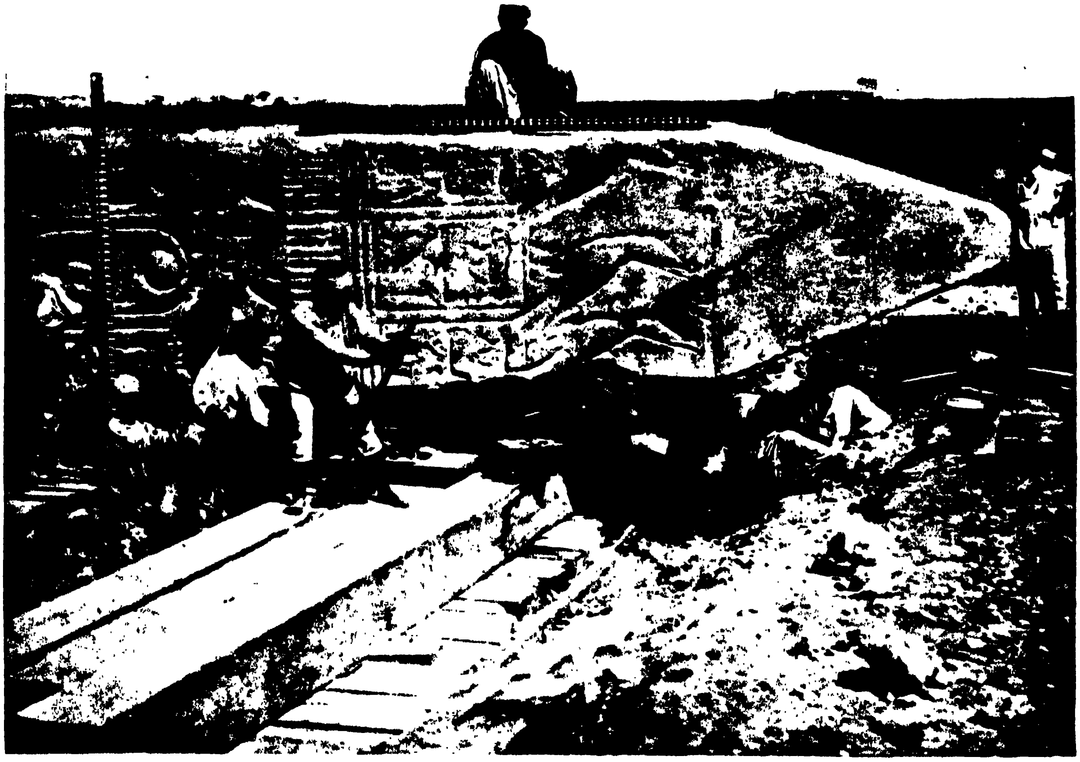


Photo. C. Prins, Paris

Prising up the Needle in order to build the framework under it

Thothmes was gathered to his fathers, and Pharaoh after Pharaoh ruled, but the granite column, with its carvings and hieroglyphics, towered serene above the land, while the tortured Hebrews groaned at their tasks beneath its shade. Little Moses, protégé of Pharaoh's daughter, played as a child at its foot, and its historian pictures the scene when "the plague of frogs squatted and croaked on its pediment, the plague of flies blackened the ruddiness of its aspect, the plague of locusts dashed in myriads against it, and the plague of darkness clothed it as with a garment." The pillar was towering skyward when Israel entered Egypt; it remained to witness her departure. Age gave place to age, and generation after generation of wise men from the west came to read the writing on the columns. Alexander the all-conquering camped at its foot as he rested on his victorious march to Memphis. Cleopatra, whose name it takes, two thousand and more years after it was carved, planted a garden of balsam in the lands that the obelisk overtowered, and caused the historic monolith to be floated down the Nile to Alexandria to

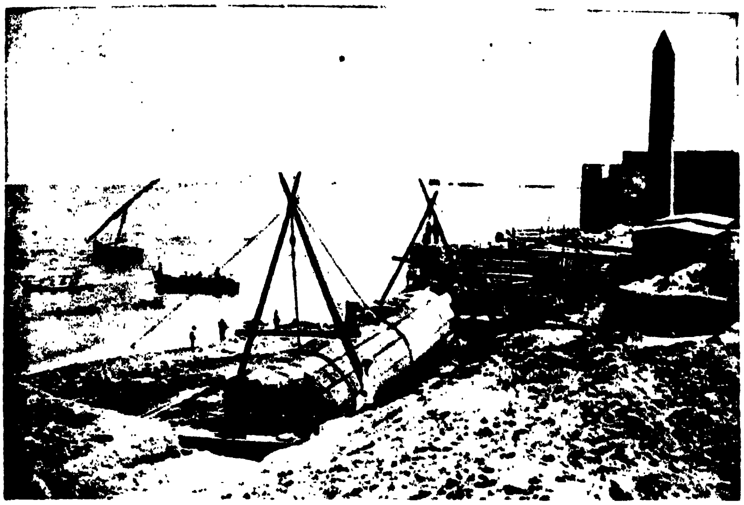


Photo: H. J. Shepstone

The Casing Finished

grace the Cæsorium at Alexandria. There the column passed another nineteen hundred years until its foundations being sapped by the encroaching sea, it fell, to be discovered, in 1801, by Sir Ralph Abercromby who yearned to carry it away to commemorate the English victory that his troops had won within sight of the fallen storied pillar.

Abercromby and his associates actually subscribed £7,000 towards the cost of transporting the monument hither, but the scheme fell through, as it did when Mehemet Ali offered it successively to George IV. and William IV. At last, after 76 years of negotiating by his predecessors, Sir James Alexander, financed by Professor Erasmus Wilson, undertook the task of bringing the Needle to England. The monument became a ship! It was enclosed in a huge steel cylinder, it was given a keel and rudder, and a deck and cabin for a crew of six. After subsiding on shore into a hidden tomb in which lay the remains of two prehistoric Alexandrians, it was hauled by tugs into the water, where a half-ton rock at once penetrated the cylinder and instantly foundered her.

The damage was made good, the six good men and true and the skulls of the Alexandrians were got aboard, and away, in tow of the steamship *Olga*, sailed Cleopatra's Needle from the land over which it had for so many ages brooded. Prosperous gales favoured the voyage for the first three weeks, but a raging tempest in the Bay of

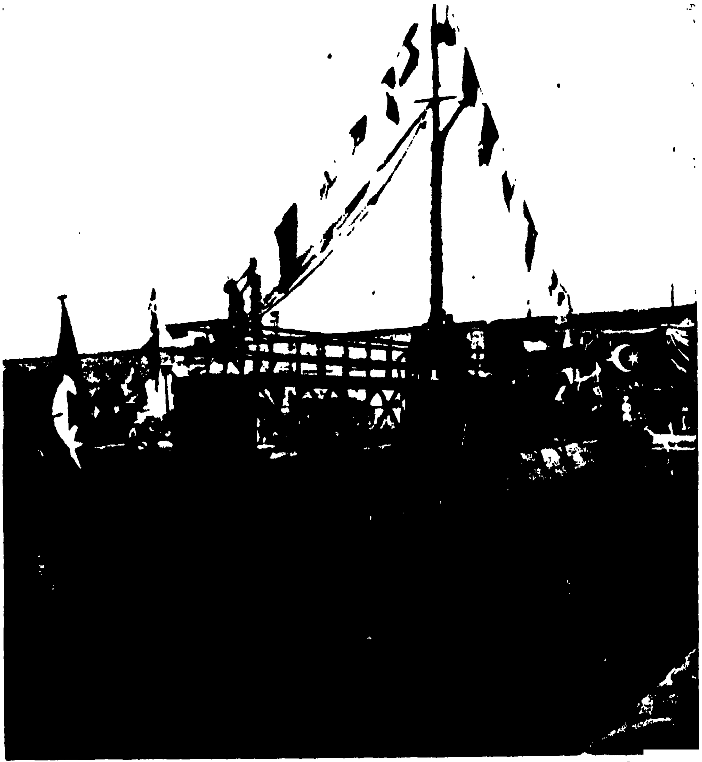


Photo: H. J.

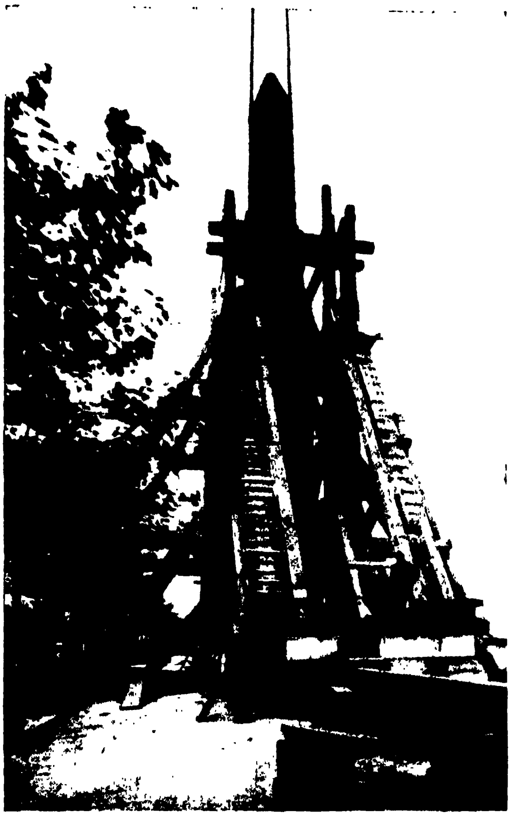
The Needle fitted out as a seagoing craft ready to start for the Thames

Photo: H. J. Shepstone

Launched at Last

No sooner was the Needle hauled into the water than a half-ton rock penetrated the cylinder, which foundered. The damage was made good and Cleopatra's Needle sailed from the land over which it had so long brooded

Biscay set the floating monolith pitching with such force that the captain of the *Olga* decided to cut her adrift with her crew on board. The ship's second officer courageously called for volunteers to save the men on the *Cleopatra*, and five tall fellows set out in a boat with him, to be swept almost instantly to destruction. Inspired by this tragic heroism, the captain of the *Olga* got a line on board the Needle, and warped a boat out to her by means of which her crew was rescued. After that Cleopatra's Needle, in her cradle of steel, went adrift in the Bay, with none to steer or control, and only the remains of two ancient Egyptians on board for crew.


Raising the Monument

When one considers the difficulties attending this enterprise in spite of the vast strides which engineering science has made in modern times it is amazing to reflect that this task of transporting giant monoliths by sea was successfully accomplished by the ancient Romans, who carried obelisks across the Mediterranean from Egypt to Rome in specially constructed ships.

Sixty days passed, and then came home news that the Middlesbrough ship *Fitzmaurice* had found the Needle careering placidly along 90 miles north of Ferrol, and had towed her into the Spanish harbour of Vigo, a profitable undertaking for the owners, who earned a couple of thousand pounds by their services.

The monument eventually came home towed by an M.P.'s yacht, and, charged with copies of the Scriptures printed in 250 languages, with current coin of the realm, with toys and tops and pipes and other representative trifles of nineteenth century production, was, on September 12, 1878, set up on the Embankment, to begin the third stage of its long career. There is no more romantic monument in London; there is none more remote from the centre of human interest, none so little regarded. The mute but storied witness of the splendours of Egypt, of the coming of the Plagues, of the Exodus, and of the transcendent glories and beauty of Cleopatra, for whom Mark Antony flung away half a world, merits more sympathetic if not more reverential interest and regard.

Who knows what things this venerable monument is still destined to witness? There seems no reason why Cleopatra's Needle should not still endure for thirty centuries to come. Will there then dwell beside the Thames a race of supermen, with powers beyond our wildest dreams, or will the Needle scornfully look down upon a race from which, as from ancient Egypt, it has watched the glory depart?

IV.—In the Depths: Natural

The Kraken

Not a Mythical Monster, but a Giant Cuttle-fish — the Nightmare of the Deep

By FRANK T. BULLEN

Author of "The Cruise of the 'Cachalot'"

PRIMEVAL man, for a very easily understood reason, looked expectantly for something blood-curdling to emerge from that inscrutable depth whereon he ventured his frail craft. And when occasionally *something* was revealed to him, even though that something did not approach his mental measurements, made before seeing it, by many a rood, he is not to be even lightly censured or scoffed at for fantastic exaggeration. Especially remembering what has been done in that line in our own day, and by folks without any of their ancestors' excuses.

Awful Visions

Moreover, it must be admitted that never, since man appeared upon earth at any rate, has the land been able to furnish us with such awe-inspiring visions as occasionally arise from the mysterious abysses of ocean. In these later days, owing to a plethora of marvels, each greater than any achievement for which our ancestors would have consigned one another to horrible deaths, we have largely lost the faculty of wonder, yet still we are often compelled against our educated wills to marvel when some living monster of the sea is pleased to exhibit itself to us. It is not then so difficult to imagine what must have been the feelings of our primitive ancestors, when they saw a gigantic cuttlefish sprawling upon the sea-surface, or entangled with a sperm whale, by which it was being steadily devoured, or loathsomely crawling over some sea-girt reef, its living network of tentacles extending for over 100 square yards.

Besides, to our primitive observer, there would be also present some dim and awful image of a dragon or a vast serpent intimately associated with the shadowy religion of those far-off days—a monster whose size and shape and purpose were all equally indefinite, and equally dreadful. When such soul-shaking ideas became concreted, as it were, in such a vision as I have hinted at, there can be little wonder that such appearances were exaggerated, and that the supermen of those days recorded not what they or their informants saw, but that which their imaginations dictated to them, and drove them to clothe in such language as they were able to use.

The Kraken Described

Now, even if we admit the evidence of those scribes who have given such horrific descriptions of sea-serpents, that they have unwittingly done their best to render all belief in such a creature impossible, it may be flatly stated that it could never surpass in awfulness of appearance and potentiality of horror the gigantic cuttle-fish, which is the food of the sperm whale. Exaggeration in such a case is folly, for the actual creature is large enough and hideous enough to satisfy the most morbid craving after horror. Even the spectacle of the octopods in an aquarium often makes a beholder feel sick or a child shriek with terror, although they are safely separated from the gazer, and are of puny size.

What, then, ought we to expect from the vision of a gelatinous cylindrical body some fifty feet in length by twenty feet in

Kraken versus Sperm Whale

(Drawn by Arthur Twidle)

the titanic struggle between the Sperm Whale and the Nightmare of the Deep, sharks appear like jackals round a lion, and may even assist in the enormous squid's destruction’ circumference, its ground colour a dirty white, its decoration splashes of reddish-brown? At one end of this great flabby cylinder there is fixed a broad flexible fin, at the other, wobbling easily within a huge collar, a head that almost seems to mark the limit of Nature's most sardonic efforts.

The Kraken's Head

In circumference this head is greater than the body, and set in each side of it is an eye, lidless, dead black and expressionless, of the almost incredible diameter of twenty inches to twenty-four inches. Above these eyes, and surrounding a mysterious abysmal and ever-working mouth, spring outwards a circle of arms, at their bases of the thickness of a stout man's waist, and at their extremities thirty feet or forty feet away, tapering to a whip lash. At least, this is so as regards eight of them, the other two, which are nearly double the length, demand a separate description.

On the inner side of each of these eight tentacles are thickly set, like pustules, circular depressions, ranging downwards in size from an ordinary soup-plate. Each is a natural air-pump actuated by the brain of the monster, and each has, in addition, set round its rim a row of tigerish claws to assist in holding on to prey. In the two long tentacles, which resemble the antennæ of an insect, and probably serve much the same purpose, the member is smooth and uniform in thickness (it is quite thin as compared with the other tentacles) until within a foot of its end, where it broadens out like a paddle, and is furnished with suckers like the other tentacles.

Now, all these lethal arms, like a living network, are ever moving, writhing, waylaying prey, and conveying it to the never-satisfied chasm in the centre, where is to be found the only bony part of the monster's structure, a huge black horny beak, very similar to that of a parrot. Apparently nothing comes amiss to that maw, certainly nothing that is brought to it by the foraging arms. And ever there pours from a cloaca in the limber neck a brownish fluid (sepia) which bedims the water, and renders that ghastly shape invisible to honest fish. Also, and establishing some devilish connection between the two, this fluid is highly impregnated with the odour of musk, as is the crocodile.

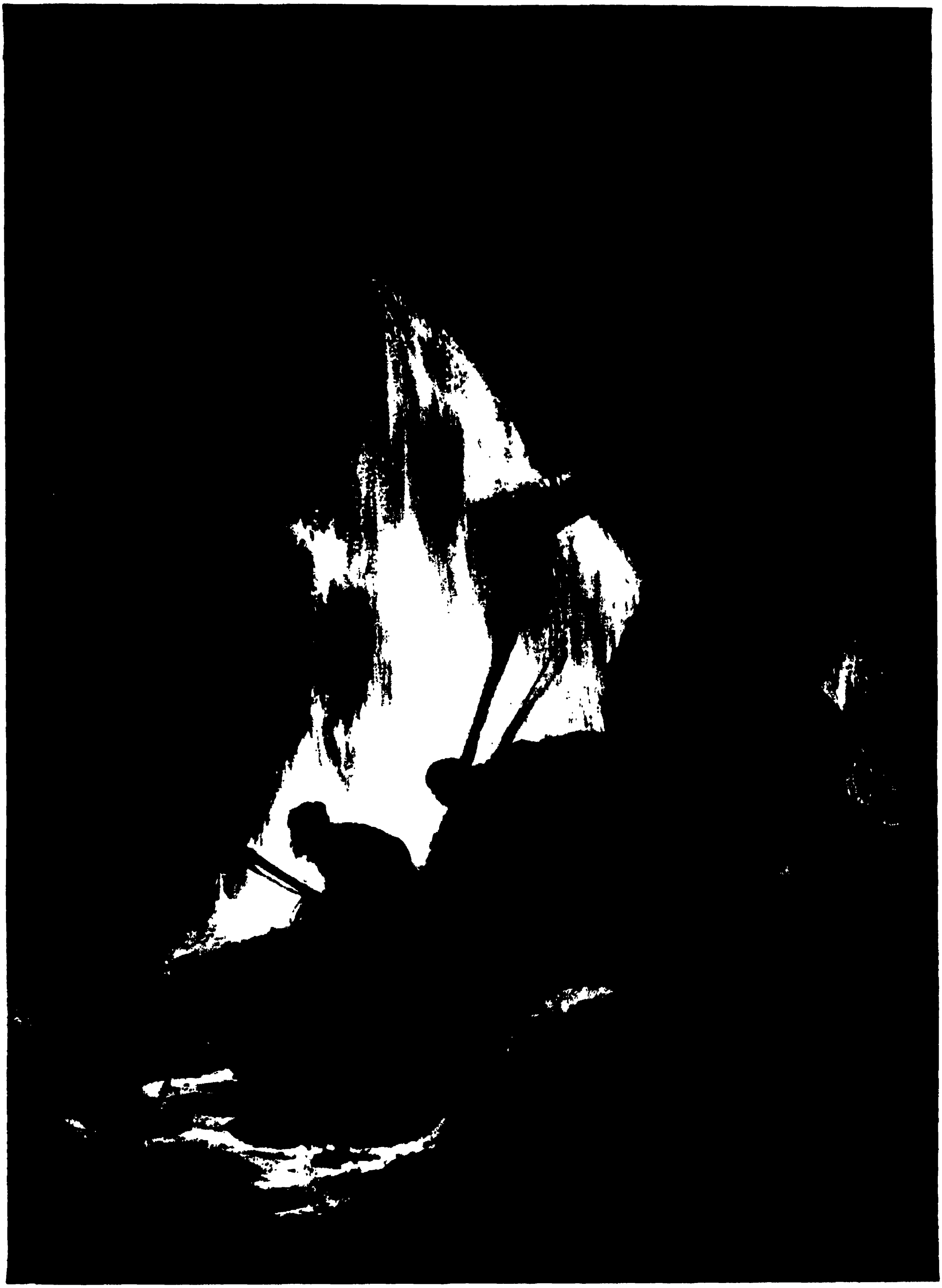
When the existence of such a creature is realised, we are not only inclined to pardon the childish exaggeration of the early writers, but to feel a sense of satisfaction that such a noble giant as the sperm whale should make his staple meals off such a chimera.

The Periscope

The Vigilant Eye of the Submarine

By CLIVE R. FENN

MARVELLOUS though it undoubtedly is, the submarine is not so modern a conception as most people suppose. So long ago as the early part of the seventeenth century, Cornelius Van Drebble, a Dutch doctor, made a successful essay with a submersible. In 1775, David Bushnell was experimenting with his *American Turtle*; in 1801, Robert Fulton was similarly engaged in France; and, during



The Tiger of the Deep

The Sperm Whale, which preys upon the Kraken, is possessed of amazing strength. Sometimes when pursued by whalers it will "breach." When this occurs at night and it soars into the air, made luminous by phosphorescence it is like the extension of some gigantic flame come from the deep.

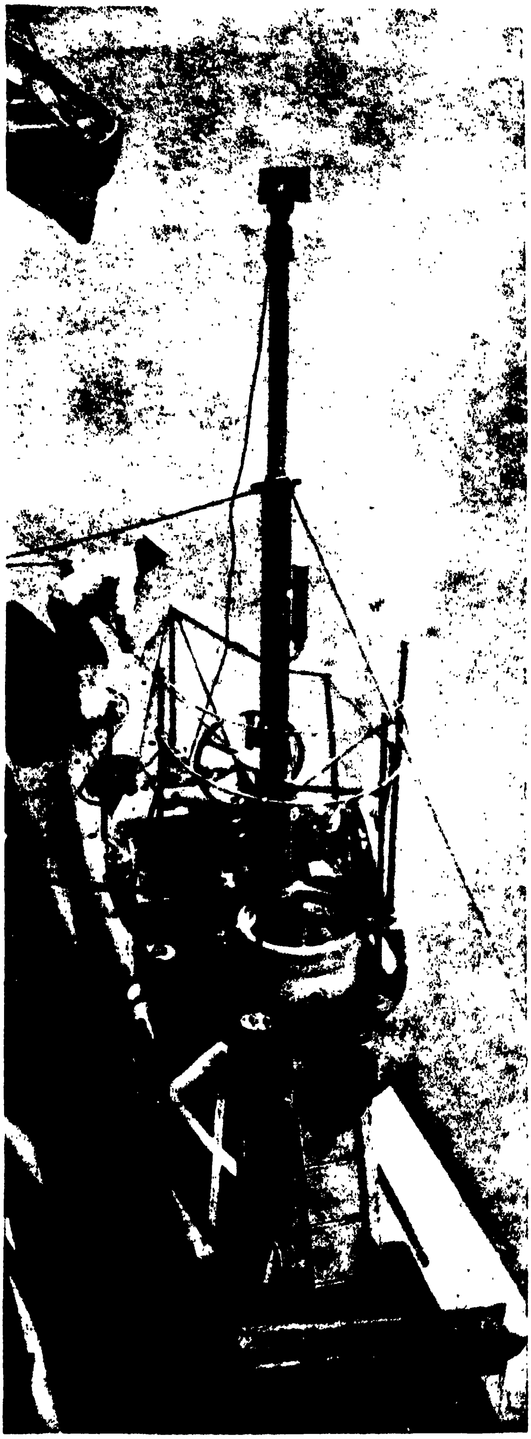
the American Civil War, the Confederates sank the *Housatoric* by employing one of these vessels.

On September 6, 1856, which was the day Emperor Alexander II. was crowned at Moscow, the ingenious inventor, Bauer, was proving the success of his submarine craft by remaining under water in it at Cronstadt during all the hours of that imposing pageant. On his emergence he was enthusiastically received, but it is doubtful whether the onlookers heard the music of the Russian Imperial hymn, loyally played below the surface by the orchestra which Bauer had taken with him into the depths.

These early types are but a memory now. Their great fault was that they were "blind." Submersion, once accomplished, blotted out the whole panorama of the seas above. Many attempts have been made to conquer this radical defect, with varying success. It remained for the clever adaptation of the principle of the camera obscura to overcome the difficulty.

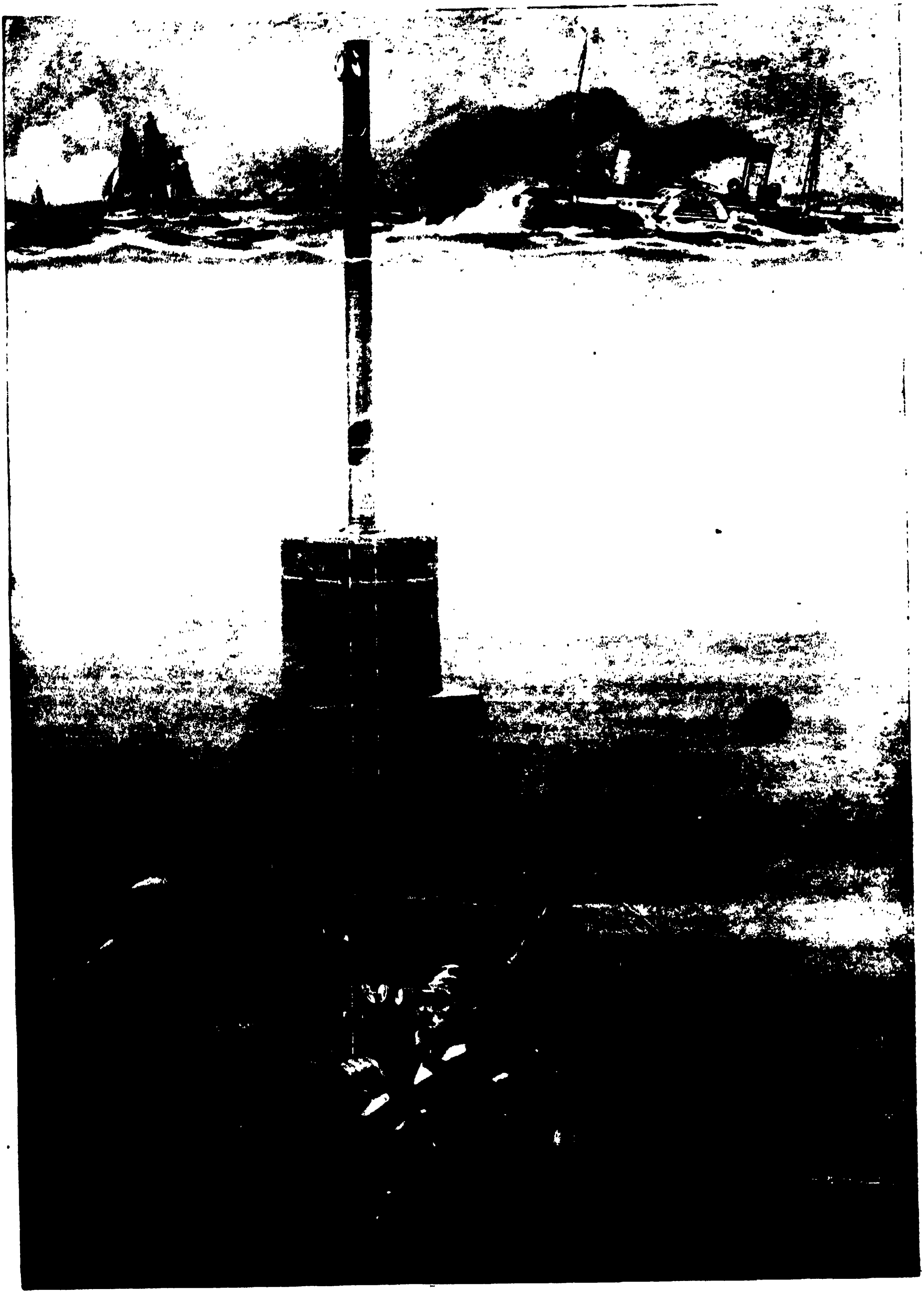
Clever and fertile inventors have produced a wonder of optical ingenuity called the periscope. This instrument is a straight, hollow tube, which protrudes above the water when the boat is submerged, and terminates in the steering chamber of the submarine. It contains an arrangement of mirrors and lenses, so placed that objects above water are reflected down to the eye of the officer in command.

When the command to "trim ship" for diving is given, the bridge is removed, the conning tower sinks lower and lower beneath the surface of the sea, and the tube of the periscope is projected upwards until it alone appears above the water line. The duty of the submarine is, of course, to strike in the dark. It glides on through the shadows of the depths, its presence only indicated, and that to the most vigilant eyes alone, by the slender tube of the periscope, which is less than 6 inches in diameter. This tube is, indeed, the eye of the



The Periscope

The tall structure in the centre of the submarine is not a mast but a wonderful optical instrument which, when the vessel is submerged, enables the officer in charge to inspect the surface



The Eye of the Submarine

(*Drawn by H. W.*

Its presence unsuspected by the larger craft upon the surface, the submarine pursues its quiet way beneath the wave, unseen itself, yet, thanks to the periscope, observing friend and foe

submarine, the link which connects the intrepid crew with the outer world.

On the most modern boats, two of these tubes are provided, so that there are always two pairs of vigilant eyes on the watch against any emergency. Continually revolved at a high rate of speed by an electric motor, the mirrors bring into focus the whole of the panorama, and the Lieutenant-Commander can follow in the smallest detail what is passing above him, locate the vessel which he has orders to destroy, and protect himself by sinking out of harm's way when danger menaces him.

Usually, the top of the periscope remains about 18 inches above the waves. Of course, the crew are in utter ignorance of what is going on, except for what they glean from the sharply rapped-out orders which it is their duty to obey. Swift obedience and no nerves—no thought of the sudden death which may come at any moment—are the prime virtues under water. Thanks to the periscope, the commanding officer can see the hostile v[illegible]el he is out to attack, though she is ignorant of his presence, and of the deadly peril momentarily menacing her.

In one way the periscope adds to the risks run by the submarine. If the tell-tale little tube is sighted, riding just above the crests of the waves, a lucky shot from the enemy may pierce the submarine's skin, and send it for ever to the bottom.

Even in times of peace the periscope is essential to the submarine's safety. As the *Scientific American* says: "When operating just under the surface, where it can see without being seen, the craft is in far greater danger, because it must depend upon its own alertness and agility to keep out of the way of other boats. The latter can hardly be expected to notice the inconspicuous periscope tube projecting from the water in time to turn their great bulks out of the danger course." Momentary inattention, therefore, in the more crowded "traffic lanes" about our coasts may easily mean the death of all on board.

It may be that even now, with the periscope, the submarine is myopic, but before it was blind. Now the upper seas can be viewed from the depths in a manner which not long since only seemed possible to the powerful imagination of a Jules Verne.

Watching for the Periscope's Tell-tale Wake

In one way the periscope adds to the risks run by the submarine. If the tell-tale tube is sighted, riding just above the waves, a lucky shot may send it to the bottom

PEOPLE THAT LIVE IN CAVES

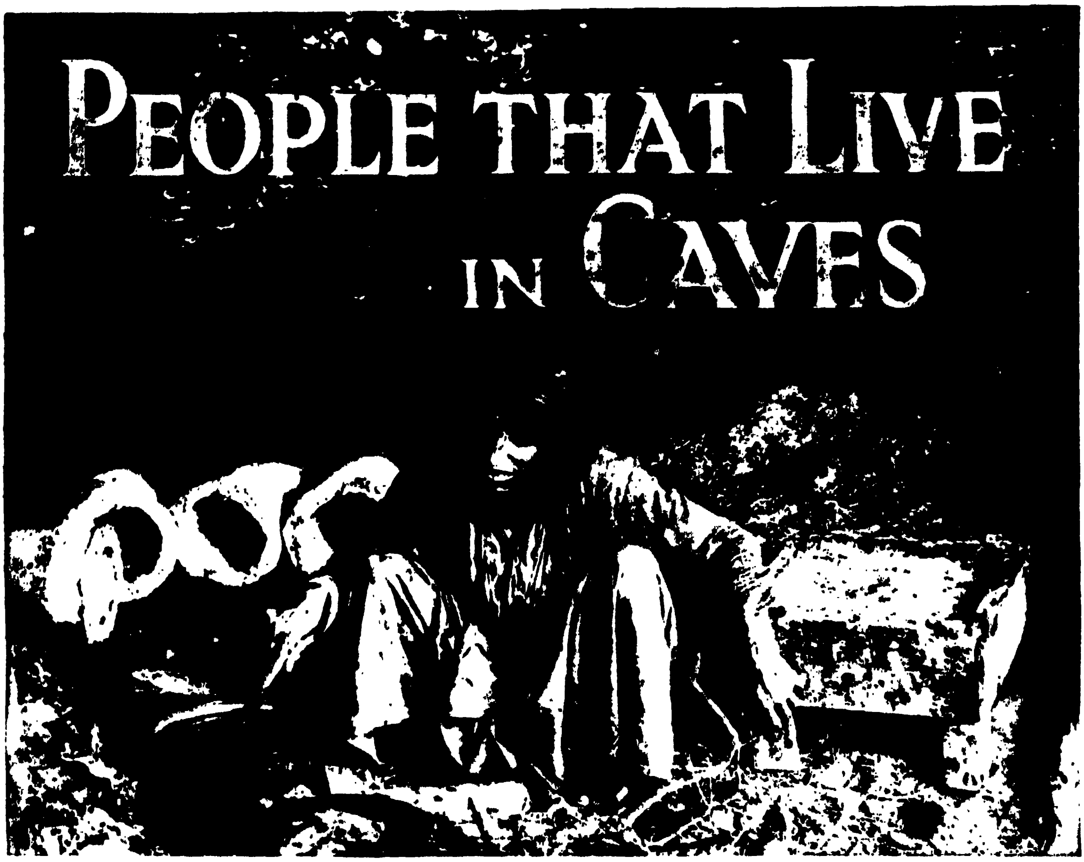


Photo Underwood & Underwood

A Cave at Endor

Even to this day the famous limestone caves at Endor are inhabited

THE wonder is, not that mankind ever *dwelt in caves, but that many* members of the race continue to do so in civilised Europe to-day. Some of our modern troglodytes are quite respectable people, living in homes of tolerable comfort, with many of the graces attaching to more ordinary places of habitation. Of certain others the physical and moral condition is little better than of those who dwelt in caves during the Stone Age.

To early man the ready-made shelter in the rocks was a house provided by Nature. Armed with weapons of bone and flint, he had to compete with the animals on fairly equal terms, both for existence and a home. And the animals he had to contend with were formidable creatures indeed. In Somerset, in the Hyæna Den, close to Wookey Hole, his remains have been found in close association with those of many animals now long extinct. Hard by the ashes of his fires masses of accumulated bones were found, showing that the cave was sometimes the resort of man and sometimes the lair of hyænas. The cave lion, the cave bear, the brown and the grizzly bear, wolves, elks, the woolly rhinoceros, and the mammoth pastured in the forests of the Mendip Hills and the Plains of Sedgemoor.

In the later Stone Age, a time long before the dawn of history, yet so many centuries nearer our own time that it might well be called a modern period, the Neolithic men occupied these caves, but, as a rule, not as a continuous dwelling-place, and they continued to be inhabited during the

Bronze and Iron Ages, right on into the realm of history.

Ten years ago, whilst a party was exploring the main cavern of Wookey Hole, I was let down into a hole in the floor, and in a bell-shaped cavity found a wooden spade and shovel. These were among the first finds of a great series, which have enabled us to picture in every detail the daily life of late Celtic and Romano-British people, who lived in this roomy, comfortable, and well-defended cave from somewhere about 500 B.C. to the departure of the Romans from Britain. Far more than a hundred tons of the material forming the cave floor have been carefully sifted, and a rich and varied assemblage of tools, utensils, ornaments, human and animal bones, and traces of food-stuff, has been recovered and placed in the Wells Museum.

Photo Topical

Santa Clara Cliff Dwellings

Not only do the cave-dwellers occupy existing recesses, they carefully pick away the soft rock to hollow out homes for themselves

In Britain, except in one or two places, where the situation is very inviting, there are no rock-dwellers at the present day. But the districts in France where Palæolithic man resided in caves are still full of troglodytes. On the Vézère and the Dordogne, on the Loir, the Loire, the Dronne, and the Seine, in the chalk and limestone hills, good-sized villages have been half-hollowed out of the rock, and half-built against the sheltering cliffs. At Les Eyzies, a well-known hotel, the Auberge du Paradis, has its guest-chambers cut in the rock. At Tro, on the Loir, a tributary of the Loire, a chalk hill is honeycombed with dwellings cut one above another, their wells, drains, and chimneys curiously mixed. A street of houses runs along the base, built against the cliff, with rooms quarried out behind, and under the road are store-rooms and stables, over which heavy traffic is, of course, strictly prohibited. Above many of these villages the chimneys stick out of the ground in the midst of gardens and vineyards. The sanitary conditions are not much better than when man was content to live in the same kind of

Photo by M. Emile Perrault-Harry

Moles among Men

The troglodyte of Tunis digs until he has attained the desired depth, and then excavates five holes in the sides of the pit he has made, one to form a passage for ingress and egress, the others to form rooms. His furniture he cuts out of the solid rock, as he requires it. Observe the large grass baskets which hold wheat and barley. In the wall of the pit are cut niches that act as granaries cave as satisfied the hyænas, and flung the refuse of his meals about the floor.

The most poverty-stricken and degraded of all these modern cave-dwellers are probably the inhabitants of Ezy-Anet in the valley of the Eure—the *sauvages*, as they are called—but even they are not without their bit of garden, gay with flowers, in front of their miserable lairs. No better, morally, but a great deal better off in their comforts, and even luxuries, are those sturdy beggars, the *gitani* of Granada, in Spain. Set amidst picturesque surroundings, with masses of cactus draping the slopes above them, and hanging down the caves, the fronts of their underground dwellings are neatly whitewashed, and the interiors spacious and clean. Ample bedsteads with showy coverlets, cooking utensils of brass and copper, and the gay dresses of the inhabitants, show how well the *gitani* know how to exploit the public benevolence.

Photo. Topical

Old Havasupai Woman

This aged cliff-dweller is 112 years of age

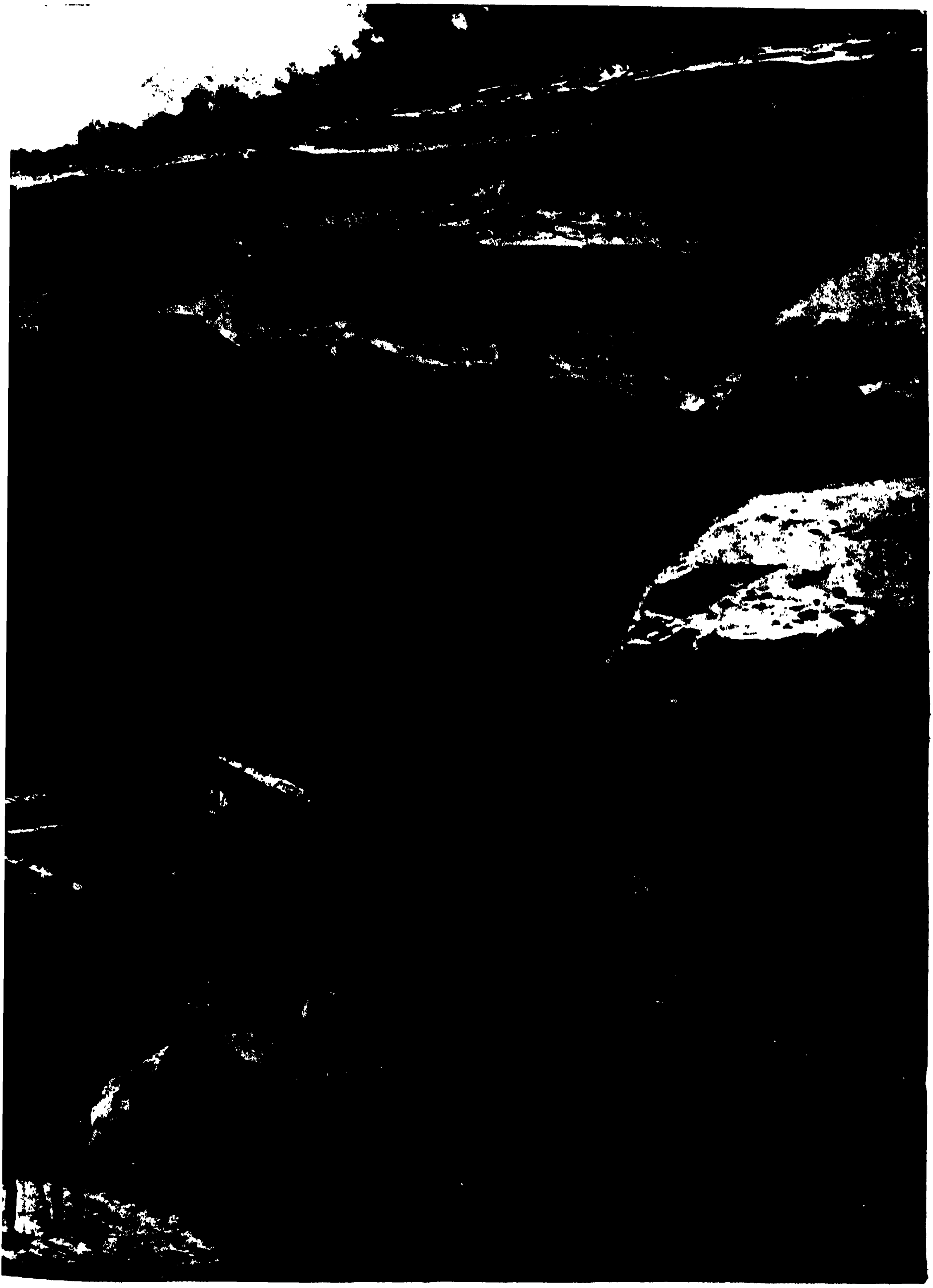
The strange cave-dwellers of Tunisia cut their houses out of the plastic clay on their high plateau, between the coast of Tunis and the Sahara. A huge circular pit is made, a kind of round courtyard like the central space in a Moorish house, and in the sides of this the rooms are hollowed, smaller holes are made for storing grain and other things, and a passage is dug connecting the subterranean home with the outside world. There are a number of these villages, and one of them approaches the dimensions of a town, having some three thousand inhabitants. There is, perhaps, no clearer instance on the face of the globe of an instinctive propensity for burrowing on the part of man.

It will be observed that most of these modern cave-dwellings have been made artificially, and are, consequently, different from the earliest dwellings of the kind; but too much must not be made of this distinction. The manufactured cave is an obvious development of the natural cave, and is often but an enlargement of it. In countless instances it is almost impossible to tell whether a cave-dwelling is entirely artificial or merely a deepened and expanded cave. In the course of time, the cave-dwelling took on architectural features. There is a cave-city of mysterious date and origin near Tiflis, in Transcaucasia, which is a notable instance, and others decorated with sculptures and paintings might be named.

THE "PALACE" IN MANC

(*Reconstruction by*

The remains of the cliff-dwellings from which this reconstruction was made are wonderfully complete. A remark been wellnigh impregnable if defe



NYON, COLORADO

Photograph)

is the immense number of rock-chambers for the storage of food. In its prime this "palace" must have w determined warriors

Underground Churches

The magnificent temples cut in the rocks in Ceylon and India are perhaps the most famous examples of cave architecture. There are others in Abyssinia, and, in the country of the French troglodytes, the underground churches of St. Emilion and Aubeterre are lofty and impressive fanes cut in the rock with a rude but genuine art, akin to that of the early mediæval churches. There is one at Royston, very richly ornamented with sculpture, and a few years ago I was let down on a rope into a curious underground chantry, just discovered, near Ingress Abbey.

The Catacombs, which were so largely used for the disposal of the dead, contain numerous churches, where the Christians worshipped in time of persecution. Catacombs exist not only in Rome, where it is said they are so extensive that if all the passages were stretched out in a line they would run from end to end of the Italian peninsula, but also at Naples and Syracuse. A large part of Paris is built over vast catacombs. Anchorites' cells were frequently carved out of the rock in Nottinghamshire and Derbyshire. There is a suite of rooms ending in a small chapel at Anker Church on the Trent; at Dale Abbey there is a smaller one; and I know another, with its crucifix clearly visible in the rock-wall, cut in the hard millstone grit on a Derbyshire tor. Not far from Nottingham Castle, the remains of an old monastery, excavated in the soft sandstone, are still visible. In Shropshire there is still extant the cave stronghold where the outlawed Humphrey Kynaston housed himself and his horse, and defied the authorities for several years in the time of Henry VII.

Impregnable Strongholds

Mention of Kynaston's hold almost incites one to write at length of the use of caves and underground workings for purposes of refuge and defence, as well as of strongholds cut in the face of impregnable crags. A handful of men could hold one of these strongholds against a multitude; and at the last gasp, even if overpowered by numbers, they could flee from stage to stage, and at last escape by concealed passages into the rocks. Once more these cliff-fortresses, like, yet unlike, the cliff strongholds of Arizona, became a formidable weapon, used both by Catholic and Huguenot, in the Wars of Religion.

Big Guns

How our Dreadnoughts' Teeth are Manufactured

By CAPTAIN J. H. HARDCASTLE, R.A.

WHEN we see a big warship lying in the offing, her funnels, her masts, her sailors, and her conning tower and bridge are the first things that attract our attention. When she salutes, the boom of her light guns compel our ears and the smoke seems to hide her hull like a cloud. But of her real fighting strength nothing is visible except the long muzzles of her sixty-ton guns, protruding idly from the sides of the turrets and looking more like spare spars or scaffold poles than engines of destruction and of death. Yet they are the very reason for the ship's existence, and, with her armour, are in fact her very soul and essence, distinguishing her from every other type of ship afloat.

Iron is the raw material in the shape of pigs from the blast furnaces where the ore is smelted and reduced to cast iron, in which form it is bought by the great ordnance firms by the thousand tons, bulking about 6 tons to the cubic yard. The first step in the fashioning of a piece of heavy ordnance from the raw pigs is to convert the iron into steel. This is done in a Siemens-Martin furnace, under the supervision of skilful chemists, who see that the correct ingredients are added in their tiny proportions, and that the impurities are burnt out to the last trace before the furnace is tapped, and the cauldrons filled for running into the mould. But here at the outset it will be well to explain the duties of the thing about to be made.

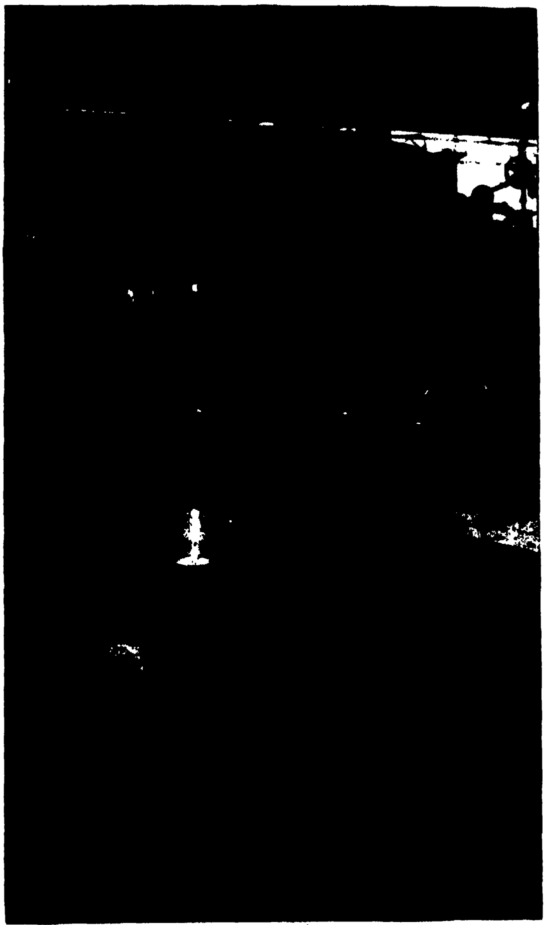


Photo by permission of Sir W. G. Armstrong, Whitworth & Co., Ltd.

The Birth of a Big Gun

When the Siemens-Martin furnace has been tapped mighty cauldrons pour the molten steel into great ingot moulds

Its work is not to make a roar or a cloud of smoke or to ease the taxpayers' pockets, or any of the thousand and one things which rise to the ordinary mind on hearing the word gun. It is designed, and built, mounted, and fired, for the sole purpose of causing a terrible explosion at a predetermined moment in a room, full of people and valuable machinery, in another ship several miles away, whose walls are made of steel armour a foot thick, and hard enough to defy all the burglars in the world.

To do this its shot has to contain several pounds of lyddite. It must also be strong enough to smash or bore through the stout iron walls. Further, it must carry the lyddite safely through the hole thus made, together with the appliances necessary to explode the lyddite a hundredth of a second after first touching the outside of the walls.

The power necessary for penetrating the armour is derived from the shot's own weight and the velocity at which it is moving as it strikes. Its striking velocity is the balance left over of the speed with which it left the nozzle of the gun, after the air through which it has moved has subtracted its toll. What that toll is may be faintly realised by trying to hold a hat out of the window, in an express train, at full speed, and recollecting that the gale then felt is a flat calm compared with the tornado experienced by the shot, as it starts with a velocity of 2,500 feet a second, or 1,700 miles an hour.

This speed is derived from the chemical energy locked up in the powder charge, which energy is released by firing it in the gun. The gas so formed presses on the base of the shot and forces it along the fifty-foot barrel with an acceleration ten

[illegible]

Lowering the Jacket

Should a mistake be made and the heated jacket allowed to seize itself on to the barrel too soon enormous loss would result

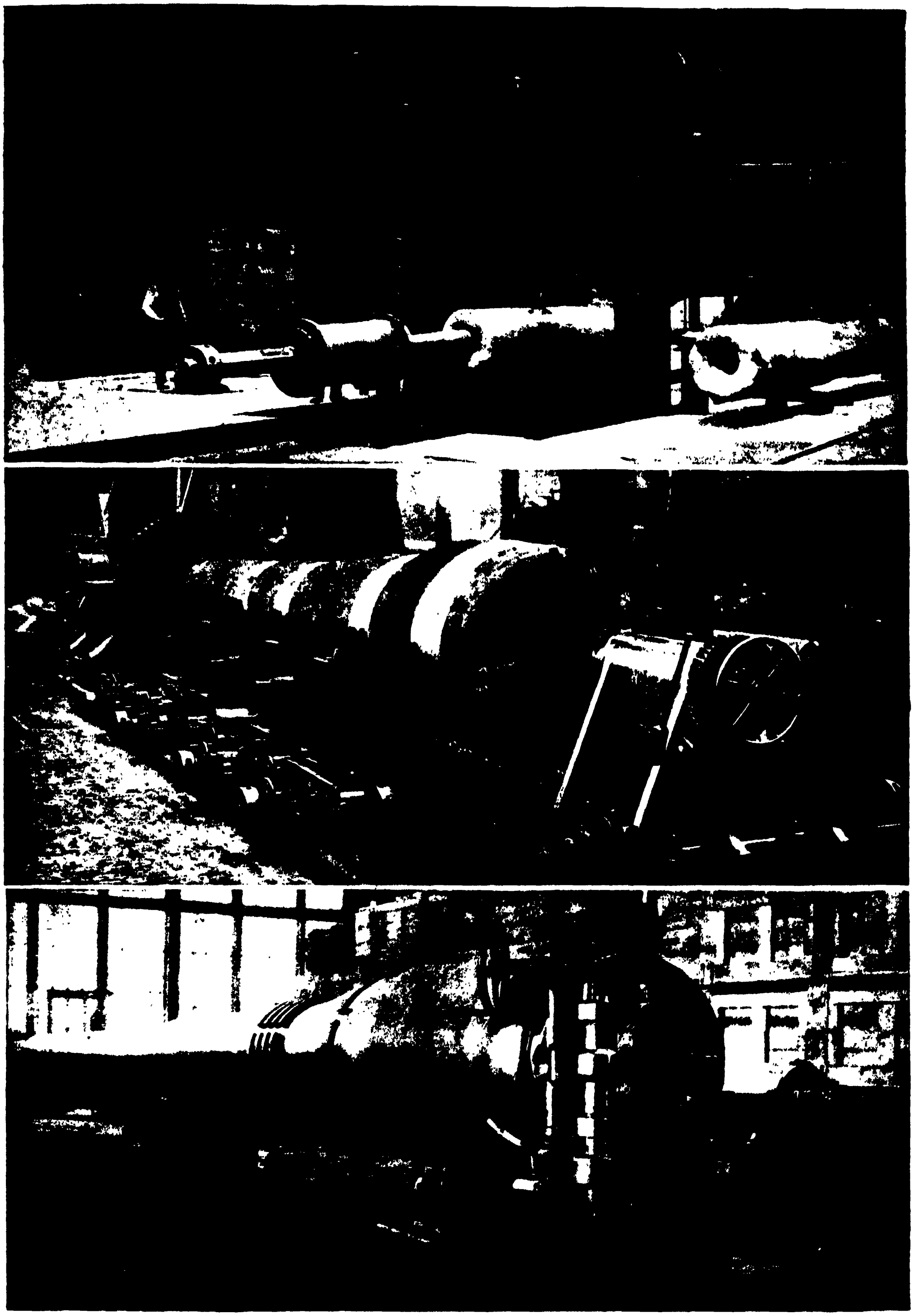
thousand times as great as that of gravity. The pressure developed to produce such an appalling effect is prodigious, and amounts at its greatest to some forty thousand pounds on each square inch or nearly three thousand atmospheres, in comparison with which the pressure in the cylinder of a motor-car, or in the barrel of a shot-gun is merely a gentle squeeze.

The shot itself weighs over half a ton, and the cartridge contains about three hundredweight of cordite—a smokeless powder, first cousin to dynamite and blasting gelatine, but of a more amiable disposition. It is equally strong, but tamer.

When the melted steel has set in the moulds, it is turned out as a solid ingot, and work is begun upon it as in any blacksmith's forge, but on a titanic scale. A hundred-ton steam hammer used to be employed to rough out the shape of the gun barrel, but now an enormous hydraulic press is used with more certain results. After shaping under the press it is rough turned on a lathe, by half a dozen or more tools at once, each cutting its slice as easily as if from cheese, though the steel parings are blue with the heat developed in cutting. After rough turning comes the fine turning, to the finished dimensions of the particular portion of the gun it is to be.

The actual gun consists of many tubes slipped over one another and named after the letters of the alphabet. A is inside, and scorched by the powder gases. B goes over A, and so on, the outside tube of all being called the jacket.

The A tube extends the whole length of the gun. The B tube is over the breech end, and is so true a fit that it has to be warmed to expand it before it will slip on. The C tube is over the muzzle end, but overlapping the B tube, to which it is locked, lengthwise, by a sort of bayonet joint, needing a small twist to engage after slipping over. The most extreme care is necessary in gauging the interior to ensure proper finished dimensions, and micrometer



Photos by permission of Sir W. G. Armstrong, Whitworth & Co., Ltd.

Three Stages in a Big Gun's Growtn

1. The white-hot ingot in the hydraulic press, which roughly shapes it
2. The roughly-shaped ingot being turned and worked upon simultaneously by eight cutting tools
3. The finished gun in the examination shop, awaiting rigid tests before being passed for service.

measurements of the ten thousandth part of an inch are very frequently essential.

Precise Measurements

A further complication is introduced by the effect of the shrinkage of one tube over the other. The inner one is contracted by the pressure of the outer, and this contraction may amount to the one-hundredth part of an inch, and has to be precisely anticipated and allowed for.

The final treatment of each piece before assembling consists of oil hardening and tempering to give the metal the proper tenacity and ductility. It is no easy matter to heat and quench a long thin tube without bending or warping it a fraction of an inch. It is carefully heated to the required temperature, and then lowered end first into an oil well, whence immediately a cloud of evil-smelling smoke arises.

All the parts being now finished and carefully inspected by a special staff and passed correct, the assembly begins. The most striking sight is the fitting of the shorter tubes round the long barrel, or A tube. The A tube is lowered into a deep pit or well and fixed in an absolutely vertical position. The huge B tube, or, perhaps, the jacket, is heated to a calculated temperature to expand it to such an amount that it will slip on, and also to that predetermined amount which will cause it, when cold, to grip the barrel with the required tension to help it withstand the pressure of the powder gas.

It is then quickly lowered over the barrel and treated with heat and cold, as required, to ensure uniform shrinkage. One part may have water from a hose played on it while another part will be warmed by means of rings of gas jets.

No exact procedure can be laid down, as such a process can only be successfully employed after long practice and experience. Naturally no measurements can be taken, yet, should a mistake be made, and the outer tube be allowed to seize on to the barrel before it is properly in its place, it would entail most expensive operations to rectify the mistake. Possibly the jacket would have to be cut off in pieces and spoilt, wasting all the expensive work already done on it.

Formerly guns were built up entirely of tubes shrunk on to one another, but wire guns are now in almost universal use, thus reverting to the earliest method of manufacture of the date of the battle of Crecy, when the barrels were made like beer barrels and hooped up with copper tapes.

The wire nowadays is wound on in layers, like a reel of cotton, on to the A tube. The obvious advantage is that each tiny piece of the metal taking the strain of the powder gas can be subjected to the closest scrutiny, before being incorporated and hidden from view. Flaws may occur in thick masses such as those used for B tubes or jackets, and no care or ingenuity can detect them. But each yard of wire can be, and is, tested up to 100 tons to the square inch, before use, so that no flaw can be overlooked. To protect the wire from accidental injury a jacket is shrunk on outside and holds everything securely together.

Rifling the Barrel

The gun, being now built up, is sent to the rifling machine, to have the grooves cut along its inside which give the necessary spin to the shot. The rifling bar, as the tool is called, is provided with a single cutter. As the cutter is drawn along the inside of the bore it is gradually revolved, and so cuts a spiral instead of a straight groove. As the rifling must be perfect, the slightest mistake will result in the spoiling of the whole gun, which by this time has had many thousands, or tens of thousands, of pounds' worth of work put into it.

Needless to say the machinery is of the most perfect description and arranged to be independent of human aid. When once adjusted and started it is automatic and self-controlling, and, apart from the break-

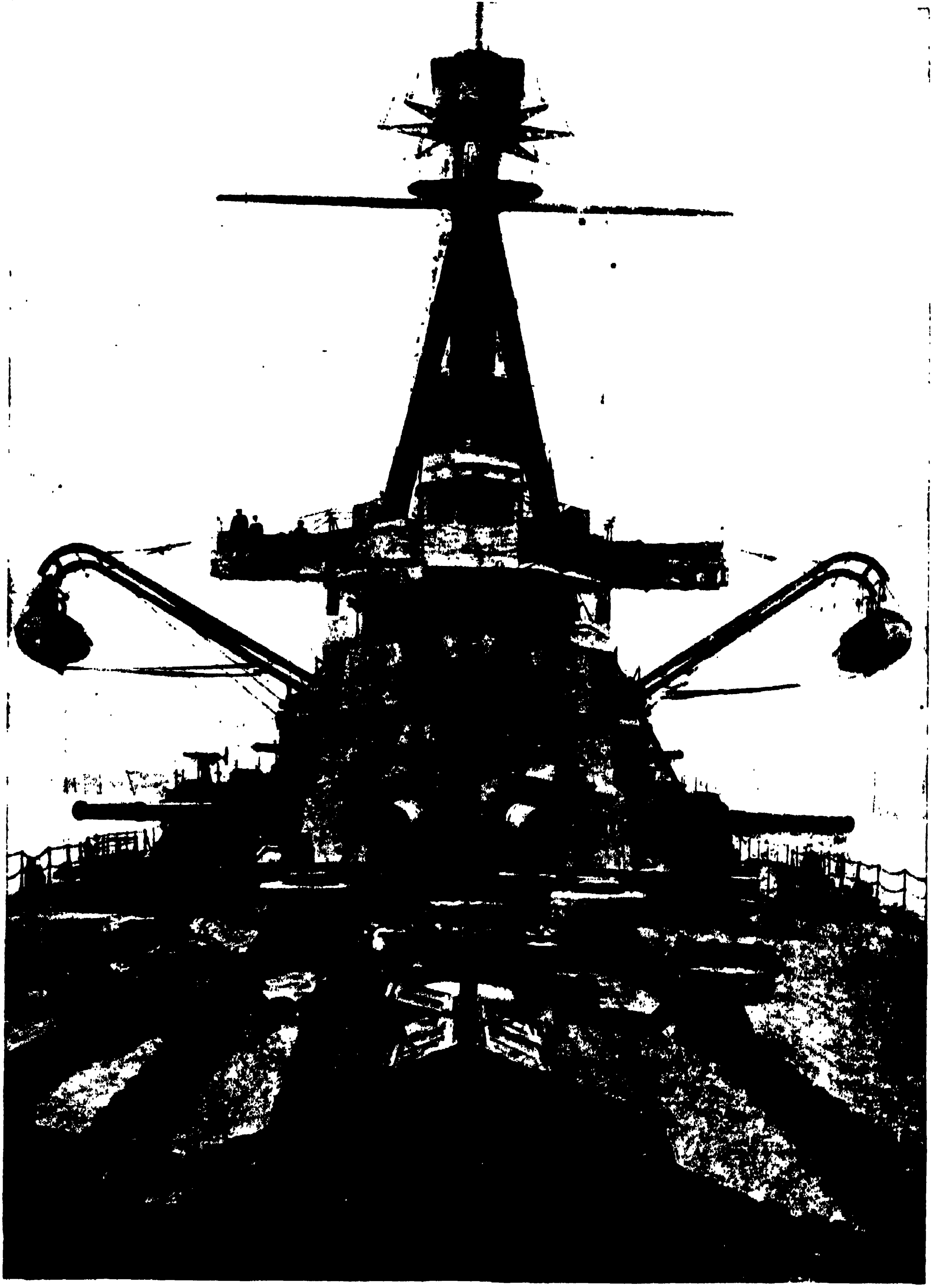


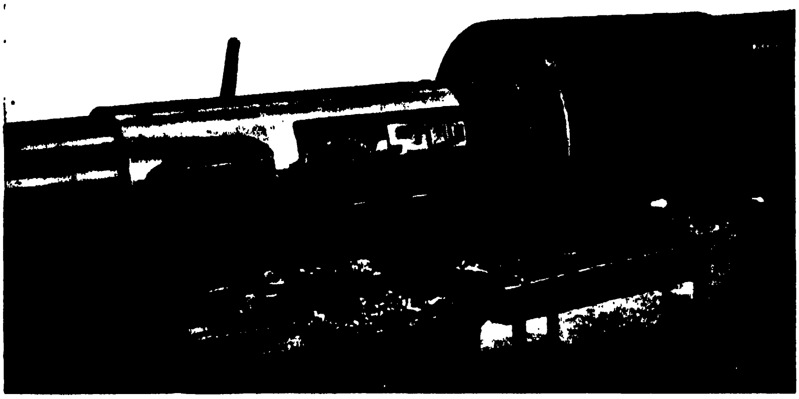
Photo by permission of Sir W. G. Armstrong, Whitworth & Co., Ltd.

The Bull-dog's Teeth

The photo shows the guns mounted complete and ready for service on board a Dreadnought. Since the firing of 200 rounds, each passing through the barrel in one-fortieth of a second, may wear out the A tube of a big gun, its actual working life may be no more than 5 seconds.

ing of the cutting tool, all risk of accidents is eliminated. But, even so, accidents do occur, and the maker finds himself with all that money's worth thrown on his hands to do the best he can with, generally resulting in the gun having the damaged tube removed at great expense, and the gun held as a reserve or used for proof firing.

The illustration shows the rifling-tool with the cutting head just emerging from the muzzle of the gun. The cut grooves can be seen distinctly, and also that several grooves have still to be cut. The large wire brush at the head of the tool is for removing the pieces of steel left during the cutting process, leaving the barrel clear in readiness for the next cut.



The Rifling Machine at Work

The large wire brush at the head of the tool is for removing the pieces of steel left during the cutting process

The gun body, being rifled, cleaned and polished, is now complete, but it is not yet a gun, as it has no mechanism to close up its breech. This mechanism is really a complicated back door very easily opened and shut, but immensely firm when properly shut. It also comprises what used to be called the touch-hole, and consequently is fitted with most elaborate safety devices, so that under no conceivable circumstances can the charge be fired until the back door is shut, locked, and bolted solid to the body of the gun. This part weighs the best part of half a ton. Yet it is slammed to and locked in about five seconds.

The door gives entrance to the chamber where the shot and the powder are placed. In order to keep the immensity of the gun clearly in mind, recollect that the total chamber is about twelve feet long. The actual value of the powder and shot from one charge runs much over a hundred sovereigns.

The finished gun is now sent to the examination shop, where it is thoroughly overhauled in every detail, and gauged by micrometer, and gutta percha impressions taken of its entire bore. Then it goes to the proof butts, where heavy charges calculated to strain it much over its working limit are fired under suitable precautions. It is again examined, and the results compared with those of the previous examination, then, should all be well, the gun is passed for service. It remains to put the gun into a position for use on a suitable mounting, surrounded with proper machinery for charging it with ammunition, and lifting it to the required angle for firing.

The turret itself is built up complete in the shops, and the guns are mounted and worked as they would be on board. When all is found to be satisfactory the armour shields are removed, and the guns taken out. Then the turret is lifted bodily by the 150-ton crane, swung over the roof, and deposited into the ship all standing. The guns and armour are then replaced, and all is ready for war.

I.—On the Land: Natural

Photo: Underwood & Underwood

A Train of Commissariat Elephants in India

Giants Among Mammals—I

Which is the Largest among Living Beasts?

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

At the beginning of the present century, writers on the more popular aspects of zoology, taking stock of what remained of the world's fauna, tried to console us for never having known the dinotherium, brontotherium, sivatherium and the incredibly huge dinosaurians and crocodiles of past ages by pointing out that we still retained two types of elephant which were at least as big as the vanished mammoth, whales huger in bulk than any mammal known in past ages, enormous white rhinoceroses as formidable as anything that the cave men met with in the woolly-coated rhinoceros of the later Pleistocene period (though small as compared to the gigantic elasmotherium of Siberia), and elephant seals and walruses, probably exceeding in bulk the seaweed-eating Rhytina.

The Rhytina was a Sirenian, and a relation of the manati and dugong. It was finally extinguished by man on the Aleutian Islands and the Asiatic coast of Behring Strait in the eighteenth century.

They pointed to the giraffe, a development in its way perhaps more marvellous both in size and extravagance of evolution than its Indian relation in the Miocene period, the antlered sivatherium; they bid us take heart of grace and rest content with what we had got, to say nothing of the chances that lay before man as creator, in the direction of breeding cart-horses which might some day attain in bulk to the size of elephants, or cattle which might recover the palm of hugeness lost amongst bovines when the last of the mighty Aurochs species was killed more than two hundred years ago in the forests of Poland.

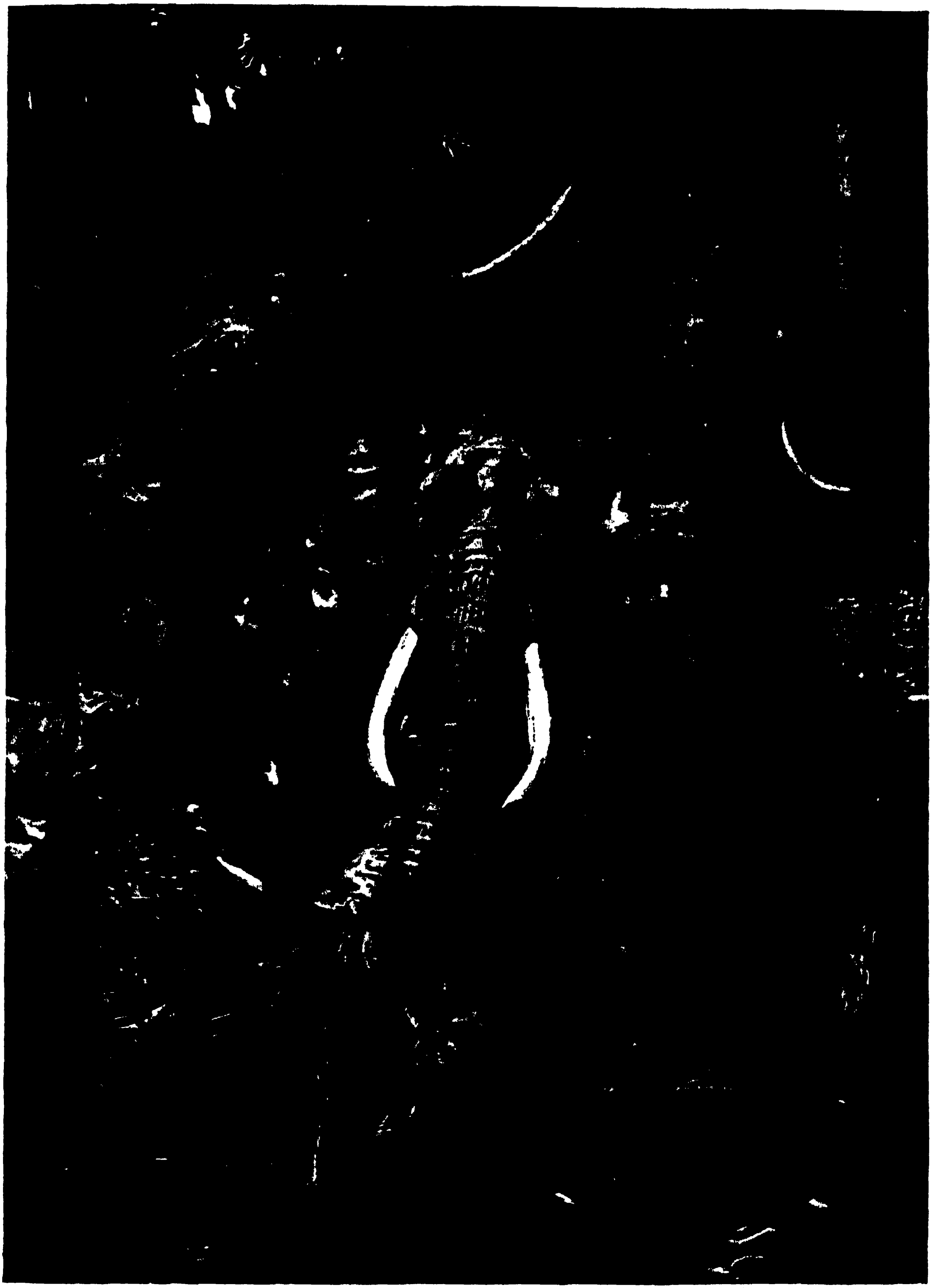
These consolatory arguments appeared in print at the beginning of the present century, but since then the world's stock of big elephants, of walruses and elephant seals, of white rhinoceroses and giraffes, has grown steadily less under the greatly increased ravages of British and American sportsmen, and British, Norwegian, German, and American whalers. The last-named having succeeded in nearly exterminating the Greenland whalebone whale, and having reduced to comparatively small numbers the immense sperm whales, are now striving (with the placid indifference of the British and French Governments) to place the elephant seals of the Falkland Islands, of South Georgia, and of Kerguelen, on the list of extinct mammals. So that our exultation in the realised fact that the world still produces very large beasts will not be of much longer duration unless we decide to take special measures to retain these curiosities in carefully protected reserves.

Photo. Underwood & Underwood

Rage Personified

A captive elephant, noosed and tethered, beside himself with rage at the indignity, in the Elephant Kraal, Ceylon

The average person of education asked to mention the biggest of living beasts would probably single out the elephant; yet, as a matter of fact the elephant is far surpassed in height by the giraffe, and is not much greater than that splendid beast in the bulk of its body. The tallest of African giraffes at the present day stands with its head (when the neck is held as erect as possible) as much as twenty feet above the ground, nearly twice as much as the height of most elephants. Giraffes have enormously long legs, as well as a very long neck, but the hinder portion of the body is somewhat poor and dwindling in appearance, relieved, perhaps, from insignificance by the handsomely tufted tail. It is at present a moot point as to whether the tallest of the varieties or sub-species amongst giraffes is that which is found in Nigeria (*Giraffa camelopardalis*



By Sir H. H. Johnston, G.C.M.G., K.C.B.

Elephants Destroying a Palm Forest

Such an episode as this was first witnessed by Sir Harry Johnston in 1883, when exploring the Upper Congo. He beheld subsequently similar instances of destruction to palm groves and patches of low-growing forest (for the sake of the fruit, bark and tender leaves) by herds of elephants in South-central, East and West Equatorial Africa

peralta), or the giraffe of the Elgon region of British East Africa. This last form, which was first discovered by the present writer, is perhaps the most striking in appearance of all the giraffes. The old bulls develop not merely three bony projections or "horns" on the top of the skull, but an additional pair of bony prominences at the back of the skull, so that when the first specimens of this variety fell to the rifles of myself and my taxidermist-assistant (Mr. Doggett), we named them "the Five-horned Giraffe." I have never seen in wild Nature any sight so striking as my first view of this enormous beast. I was riding a little in advance of the caravan over the lofty plateau to the south of Mount Elgon, and coming to a rather thin portion of the forest I believed I saw in front of me the effects of a great bush fire, the upstanding, blackened trunks of huge trees, silhouetted against the sky, these trees apparently rising from the tops of mounds or ant-hills. To my surprise, however, one or other of these blackened trunks moved slightly, and what I had taken to be a tree half destroyed by fire, was a gigantic male five-horned giraffe, with a white belly and whitish legs (screened at first from sight by the thorn bushes), and a long neck and body almost darkened to a uniform sepia brown. The younger males and females of this form were the ordinary giraffe colour of pale yellowish-brown, with dark brown or blackish blotches, these markings really being the remains of a former network of whitish spots and stripes on a darker ground—the original skin decoration of the early ruminants.

We see this in the very distinct Somali species, the reticulated giraffe, now nearly killed out by British sportsmen. This is, as regards coloration, the handsomest of all giraffes. It is a deep wine-red in colour, variegated with a regular network of thin yellowish-white lines. No form of coloration could well be more deceptive to the

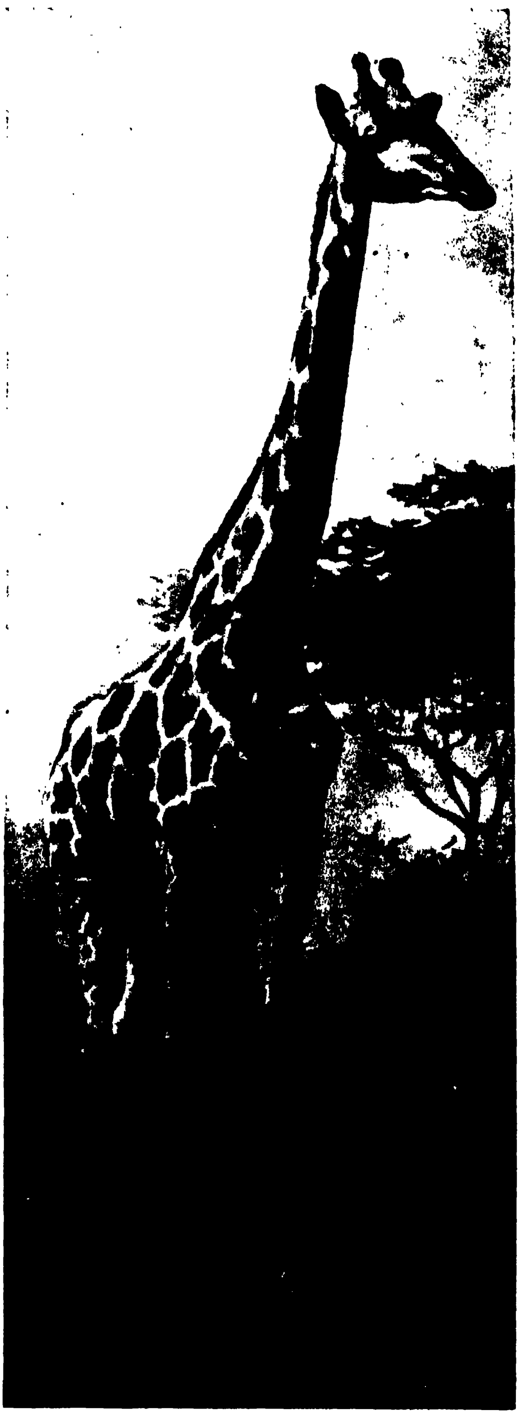


Photo. Underwood & Underwood

The Biggest of Beasts

The elephant is far surpassed in height by the giraffe, and is not much greater than that splendid beast in the bulk of its body. The tallest of giraffes carries its head 20 feet from the ground

eye, and Lord Delamere revealed this by his remarkable telephotographic pictures of these reticulated giraffes standing amongst tall trees and almost indistinguishable from them. The whitish lines on the red-brown ground of the giraffe's hide exactly imitated the criss-cross, bare, grey twigs and branches of the thorn trees with their dark red trunks.

Photo sent to Sir H. H. Johnston by the New York Zoological Society

A Pygmy Elephant

In the forests of the Congo basin there is a pygmy subspecies of elephant, only between 5 and 6 feet in height, but with good-sized tusks

The oldest systemic name for the Indian elephant was *Elephas maximus*, for it was believed in the eighteenth century that the Indian was bigger than the African elephant. The point as to the relative sizes of Asiatic elephants is still undetermined. The Indian sub-species or variety is seldom as much as ten and probably does not exceed 11 feet in the largest specimens at the topmost ridge of the head or back; but it is stated that the Malay elephant in Sumatra is bigger, and that specimens are shot from time to time which would measure a height of about 12 feet from the ground. There is a fine example of the Sumatran elephant, measuring 11 feet in height, in the Museum at Munich. The male elephant of Sumatra and the Malay Peninsula—there are also elephants in Borneo, but they have probably been introduced within historic times—is further interesting from the fact that its young is for some three or four years after birth almost covered with hair; in fact, the hair on the forehead and back of the little Malay elephant grows in thick tufts of blackish-brown. The young of the Indian elephant is also hairy, but not to such an extent. The Malay elephant may also bear tusks of considerable length, longer but rather more slender than those of the Indian elephant, and there are other points in connection with the conformation of its molar teeth which suggest its possessing slightly more affinity with that near relation of the living Asiatic elephants—the mammoth. The mammoth, which probably did not become completely extinct in Alaska or Western Europe till ten to twenty thousand years ago, was, in its old-world form, not larger than the existing types of Asiatic elephant. It had retained in the cooler climates of Europe and Central Asia a much greater degree of the original hairy covering of ancestral elephants, and during the approach of the Ice Ages this developed into the shaggy coat familiar to us not only from the drawings of primitive man but from those marvellously preserved specimens of the mammoth found embedded in the ice of Siberia. But the mammoth developed its tusks to an extravagant extent (over 15 feet in length and nearly 800 lb. in weight), far exceeding anything recorded of the existing Asiatic elephants at the present day, and making somewhat insignificant the large tusks of living East African elephants, though these occasionally attain to a length outside the jaw of 6 feet, and to a weight of nearly 200 lb.

One of the earliest of the true elephants (*E. meridionalis*), and perhaps an ancestor

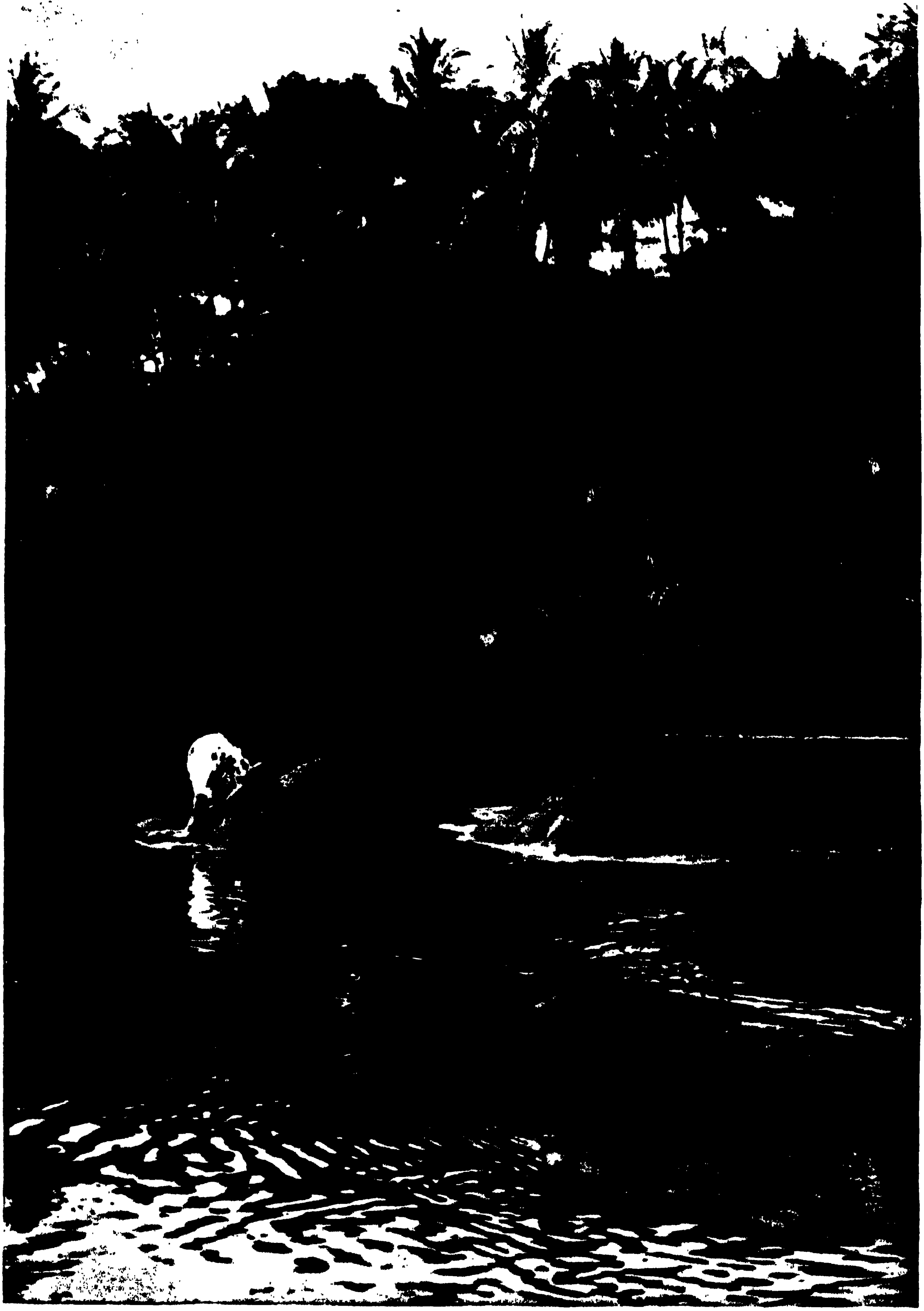


Photo: Underwood & Underwood

Indian Elephants at their Favourite Pastime

The Mammoth, which may not have become completely extinct in Alaska or Western Europe till 10,000 to 20,000 years ago, was probably not larger than the biggest type of living Asiatic elephant. This photo was taken in the interior of Ceylon

of the existing African form, once lived in England and France, and attained to a height of from 12 to 14 feet. The extinct dinotherium developed in Europe to an enormous size, having been about 18 feet long, though we know nothing as to its height above the ground. The great American mastodon was, perhaps, not more than 13 feet in height in its largest examples, but it was greater in average bulk than the modern elephants, and its extraordinarily stout limbs terminated in larger, more spreading toes.

Photo by Sir H. H. Johnston

The Sumatran Elephant

The elephant of Sumatra and the Malay Peninsula is bigger than the Indian elephant. Specimens are shot from time to time which would measure a height of 12 feet from the ground. The above is a fine example of the Sumatran elephant, measuring 11 feet in height, in the Museum at Munich

It is interesting to note, in reading the works of early nineteenth century pioneers in South Africa, the opinion that the African elephant of recent times attained its greatest development of size and height to the south of the River Zambezi. It was believed by those who first explored South Africa that the elephants of Cape Colony and the Southern Transvaal reached to a height of 13 feet at the shoulder. But their tusks, though comparatively large and thick, did not attain to the great dimensions found in Equatorial East Africa. In the forests of the Congo Basin (and it is said also of Western Liberia) there is a pygmy variety of elephant, only between 5 and 6 feet in height, but with good-sized tusks. This form has smaller ears than the other African elephants, and is quite a distinct sub-species, first noted by Livingstone in 1869.

I.—On the Land: Natural

WATERFALLS

By GRAEME WILLIAMS, F.R.G.S., F.G.S.

Photo by permission of the British South Africa Co.

The Victoria Falls, Rhodesia

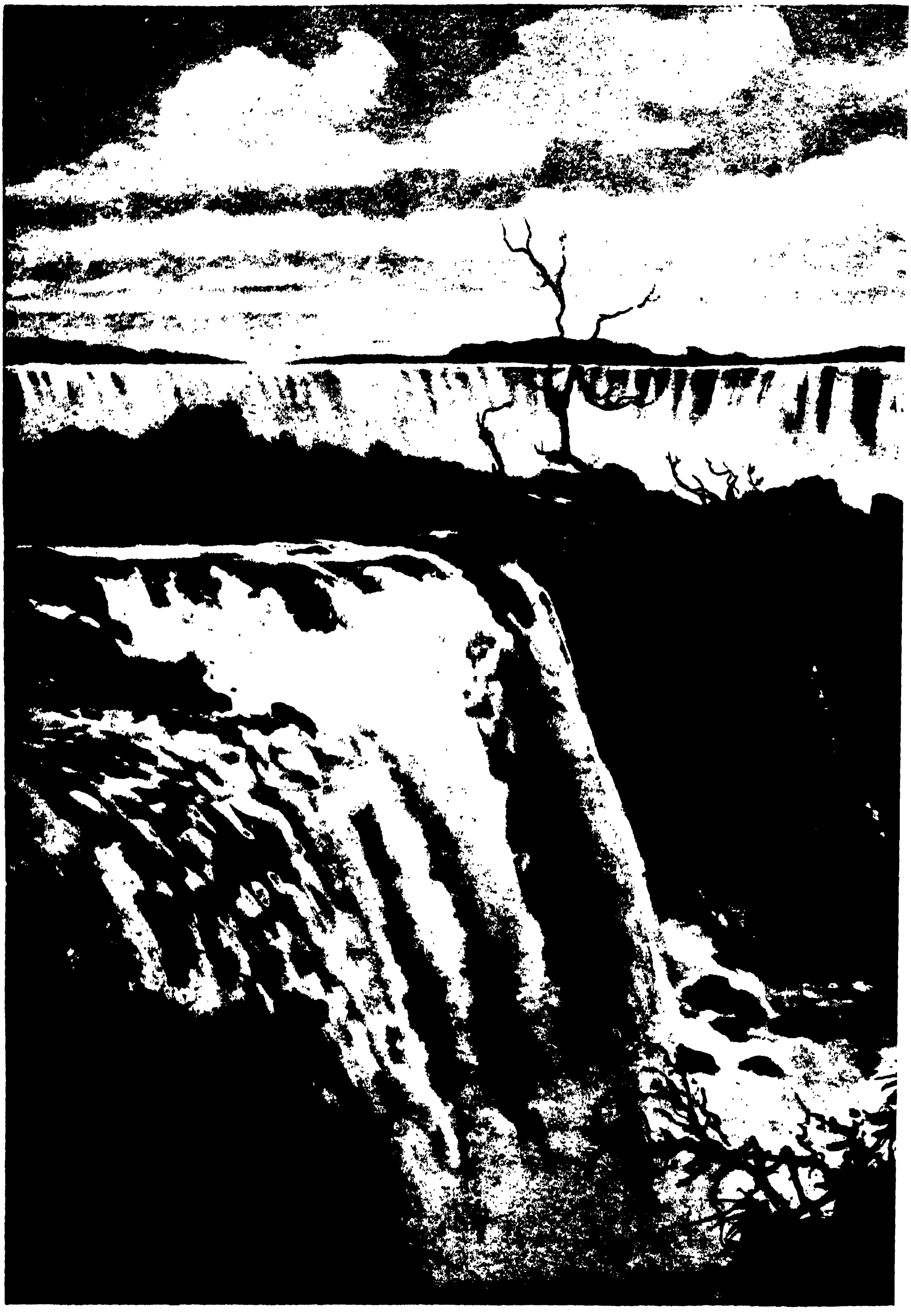
At its widest part, some 1,860 yards, the *Zambesi* River plunges suddenly over a chasm ranging from 250 to 350 feet in depth, more than twice the height of Niagara

OF all Nature's marvels there are none which have moved the sense of awe in man more than the world's great waterfalls. In whatever remote corner of the globe they have been newly found the discoverer has reported that native inhabitants of the district regard them with veneration. In many cases, indeed, the deep roar of the "smoking water" is accepted by savages as a warning to keep away from holy ground, and dusky generations have lived and died, within hearing of the thunder of some great fall, without a single individual having ventured to penetrate the surrounding screen of forest and gaze upon the majestic spectacle.

Nor is this species of spell confined to uncivilised man. George Thompson, who first discovered the Aughrabies, or Hundred Falls (christened by him King George's Cataract), on August 15, 1824, relates in his diary the impression which this great body of water, loftier than the later-discovered Victoria Falls, and twice as high as Niagara, made upon him.

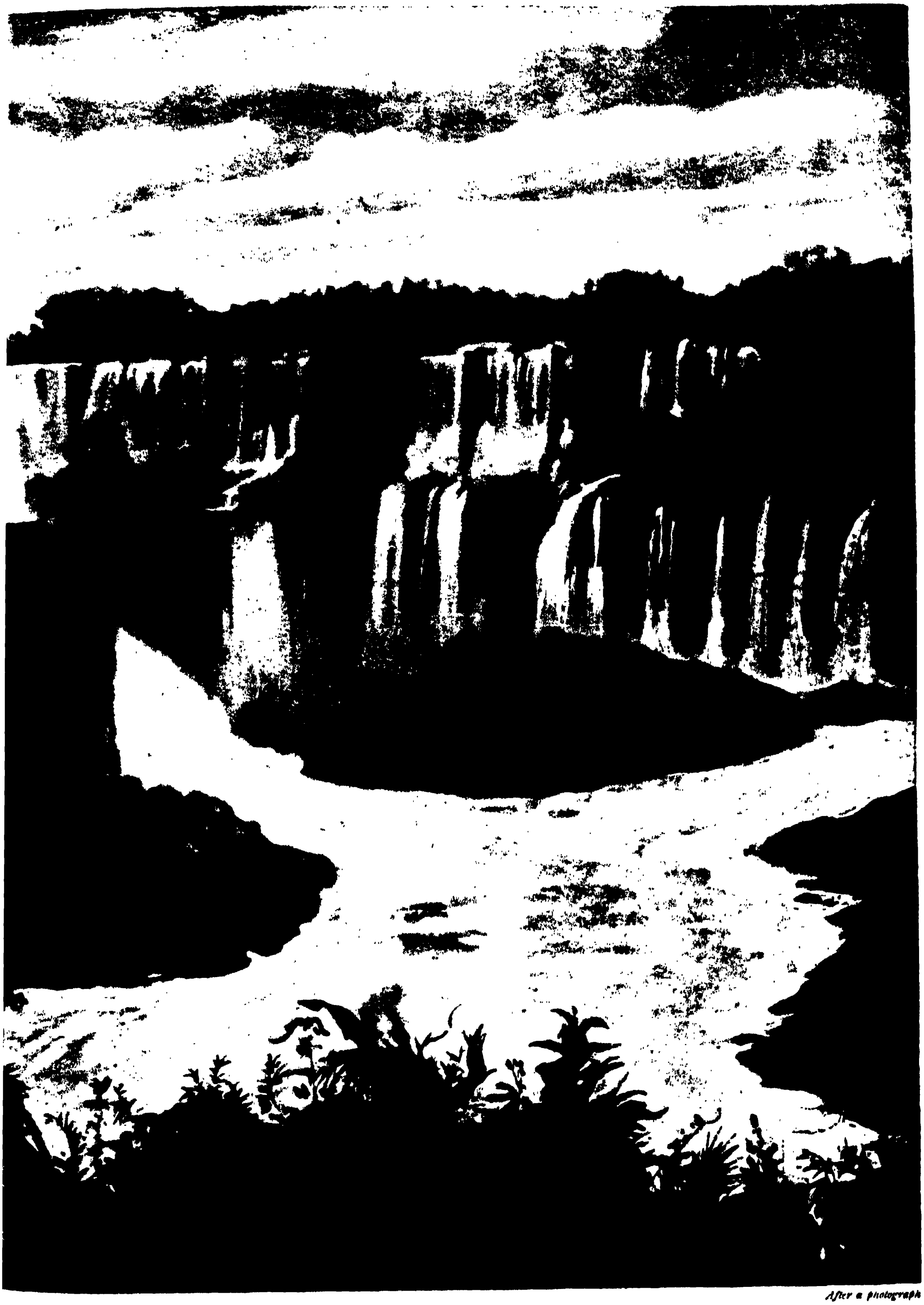
"I stood upon a cliff nearly level with the top of the fall and directly in front of it," he relates. "The beams of the evening sun fell upon the cascade and occasioned a most splendid rainbow, while the vapoury mists arising from the broken waters, the bright green woods which hung from the surrounding cliffs, the astounding roar of the waterfall, and the tumultuous boiling and whirling of the stream below, striving to escape along its deep, dark, and narrow path, formed altogether a combination of beauty and grandeur such as I have never before witnessed. As I gazed on this stupendous scene I felt as if in a dream."

Because of its remote position (some 240 miles from the mouth of the Orange River in the north-west of Cape Colony) this immense body of water, recently described by Dr. William Macdonald, of the Union Department of Agriculture, is all but unknown, even by name, to the general public, but any of the million visitors who each year crowd to view Niagara will testify to the feeling, almost of terror, roused in them by their first view of one of the most powerful and destructive things in the universe, wantonly wasting in sheer display, as it seems to them, energy sufficient to



THE RARELY VISITED CATARACTS OF YGUAZU, AT

These falls, situated in the remote wilderness, far from civilisation, form one of the grandest spectacles in th
Their energy is estimated to be about 14,000,0



After a photograph

FRONTIERS OF BRAZIL, THE ARGENTINE, AND PARAGUAY

The cataracts, 215 feet in height and variously estimated to extend over 2 to 3½ miles, are more than a score in number. power, more than three times that of Niagara perform a large proportion of the world's work.

In a later article we shall note at greater length the immense potentiality of the world's great falls, when tamed for man's use and harnessed to electrical machinery. It is a mistake to suppose, however, that the great waterfalls have no natural uses in the scheme of the universe. They provide, of course, a natural frontier which in various parts of the world, notably at the Guayra Cataracts and Falls of Yguazu, between Brazil and Paraguay, have proved stronger than Dreadnoughts or fortresses in the protection of a peace-loving people. In the seventeenth century the Jesuit missionaries in South America rescued the Guarani nation from the depredations of the Mameluke slave raiders, by leading them from their houses above, to new settlements below the great falls of the river Parana. But far more important has been the function of waterfalls in the ranks of Nature's engineers.

The most frequent reason for the existence of a waterfall is the occurrence beneath a river bed, where an irregularity of level occurs, of three different geological strata, so arranged that the hardest lies between two softer ones. In such a case the river will have no difficulty in cutting for itself a smooth passage through the upper soft stratum, but it will not be able to pursue the same steady slope when it touches the harder stratum beneath. Consequently, when the opportunity occurs it will fall over, instead of cutting through this formation. However small the fall may be, the river will naturally drop with a certain force over the hard edge of the rocky stratum on to the softer stratum beneath. In this way the lower soft

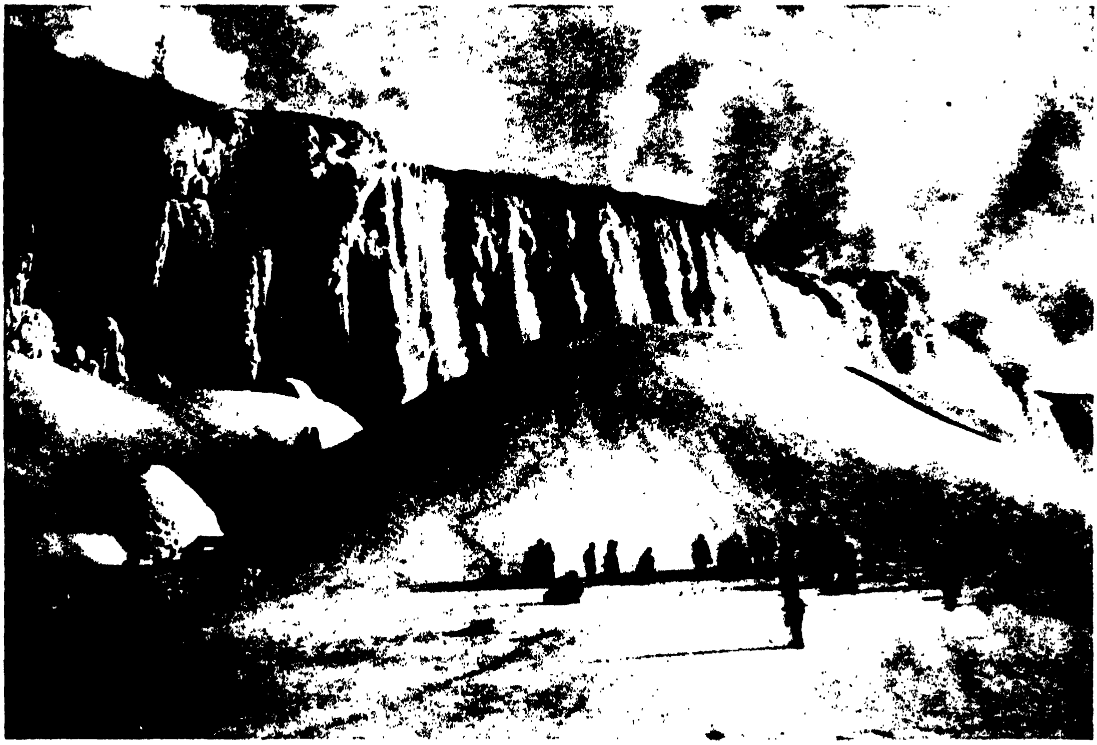


Photo: J. S. Johnson, New York

Niagara Falls in Winter

The greatest height of Niagara is 162 feet, on the American side; the greatest width 2,600 feet at the curving crest of the Horse-shoe Fall. Its energy is estimated at 4,000,000 horse-power

Photo by courtesy of the Queensland Government

The Tully Falls, Queensland

Waterfalls have been picturesquely described as "Nature's hour-glasses," from the fact that the ages of the rivers that feed them may be calculated from their slow change of position

formation is gradually eroded, so that it ceases to support the hard stratum above, which consequently collapses. Thus it happens that most waterfalls are constantly undermining their own edge. As this drops away the falls gradually recede up-river, leaving behind them a constantly increasing length of gorge, or channel, which they have created by persistent sapping and mining. In the course of millions of years one waterfall, with a sufficient stream behind it, could bisect a continent.

Nature's Hour-glasses

Waterfalls have been picturesquely described as "Nature's hour-glasses," from the fact that the ages of the rivers that feed them may be calculated from their slow change of position. It has been found that Niagara, for instance (182 feet in height, and 2,600 feet in width at Horseshoe Falls) by its incessant pounding, eats its way back from one to five feet every year, and therefore elongates the gorge below by that amount. From this fact experts have calculated that it has taken Niagara some 25,000 to 35,000 years, at least, to excavate its 7-mile gorge.

Since the days of the great discoverer, Livingstone, it has usually been asserted that the Victoria Falls on the Zambezi are an exception to the general rule, and, as one writer puts it, "owe their origin to a totally different cause, being due to a convulsion of Nature, by which a rent right across the stream, fully a mile in length, 80 yards broad, and over a hundred feet deep was made." Nowadays, however, we grow increasingly sceptical of those great cataclysms formerly invoked to explain every departure from the normal. In an able paper on the subject, Mr. A. J. C. Molyneau, F.G.S., F.R.G.S., has put forward evidence that even these great falls were formed in the normal way. If so, it must have taken them roughly 250,000 years to cut out the 40 miles of tortuous cañon which lies below them.

Many people will be surprised to learn that neither Niagara nor the Victoria Falls, nor the Aughrabies already mentioned, stand unchallenged as the mightiest of their kind on earth. South America has its own Niagara and Victoria Falls. From what I gleaned in Paraguay a few years since concerning them, I shrewdly suspected that the Falls of Guayra, shown on the colour plate, and of Yguazu, of which only a small portion can be shown on the double-page picture, were of at least as great moment as either of the better-known falls. Unfortunately the almost unprecedented floods of 1905, when the Alto Parana River rose 157 feet between its beetling walls, made it impossible to reach and measure them. This work has been done, however, by Mr. W. S. Barclay, who gives the total fall from upper to lower river at Guayra, including the upper cascades, as 810 feet. At normal times the volume of water is reckoned at 13,000,000 cubic feet per minute, whilst at times of flood (such as in 1905) that estimate may be trebled.

"The Guayra Cataract is the mightiest, because it is the most compactly frantic water-power awaiting man's harness on earth," asserts Mr. Barclay. "The whirlpool rapids of Niagara, where Captain Webb lost his life, are a quiet duck-pond by comparison."

Waterfall Land

From Guayra to the Falls of Yguazu (which occur near the point where the frontiers of the Argentine meet those of Brazil and Paraguay) the intervening space of 125 miles is so scored by cascade and torrent that Mr. Barclay aptly christens the lonely and beautiful district "Waterfall Land." The lower cataracts themselves are very extensive, being variously estimated to extend from 2 to 3½ miles. There is no lovelier scene on earth than this remote series of cataracts, some 215 feet in height, divided into more than a score of separate falls by rocks and forest-clad islands.

By A. J. Black

The Mightiest Water Power on Earth

The Falls of Guayra, between Paraguay and Brazil, are 310 feet in total height. In times of flood their flow of water equals from 25,000,000 cubic feet per minute upwards. The lake whence they emanate is 2½ miles wide. The average width of the gorge is about 500 yards; when this contracts suddenly to about 70 yards, it renders the Guayra Cataract "the mightiest because the most compactly frantic water power awaiting man's harness on earth"

I.—On the Land; Natural

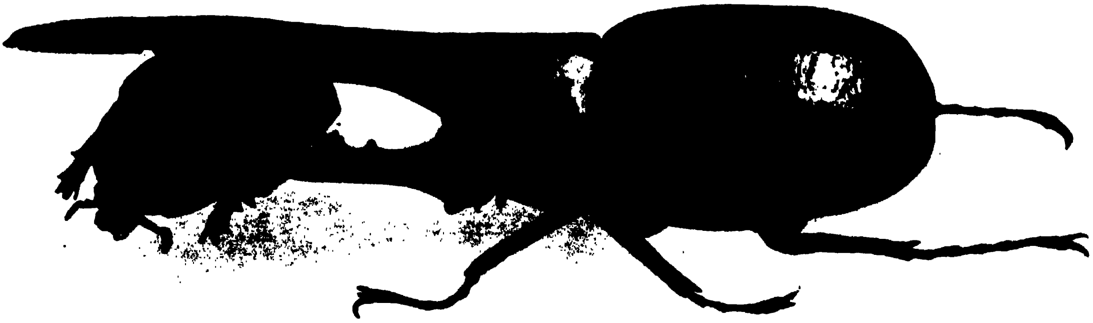


Photo by Harold Bastin

The Victor

Having vanquished his rivals in courtship the huge Hercules Beetle of South America has been seen to carry off his mate in this way

The War of the Insects

How they Fight and Prey Upon Each Other

By HAROLD BASTIN

Author of "Insects

SOMEONE has said that the use of war is to keep the peace, but this dictum only holds good among civilised humanity. Children, savages and, above all, animals make war on such slight pretext that it is often difficult to say where their games end and their combats begin. The fact is that a fighting instinct exists, deep seated, in the composition of all living things. Even the plants the gentle, kindly plants about which poets are wont to rave—engage in fierce struggles, the stronger, dominant kinds ruthlessly strangling or crushing the weaker out of existence. These contests, however, are enacted with the grim tardiness which characterises vegetable movement, and are thus apt to escape remark.

With animals the case is different. Their battles are short and decisive, and we experience less difficulty in explaining the origin of a given feud and in comprehending its issue. Take, for example, the insects—those marvellous beings whose species are said to outnumber, by at least four to one, all other kinds of animals whether small or great. Perhaps the reader has cherished the belief that an insect's life is one of unbroken harmony. Nothing could be more fallacious. True, certain insects evince a notable clannishness, and dwell amicably in vast social communities; but outside these family gatherings we find evidence of endless strife.

Photo by Harold Bastin

A Contest between Two Male Stag Beetles

Some insects are veritable gladiators, seeming to fight for the sheer love of conflict. This is the case with the so-called "praying" mantids.

A few other insects display the same

ungovernable pugnacity for which the mantid is famous. But in the vast majority of instances we find that when insects engage in war they are actuated by a definite policy. The chief incentives are acquisitiveness and self-defence, while, during the season of courtship, many male insects habitually fight for possession of a coveted mate. This is the case with our own stag-beetle. The mandibles of the male are enormously developed, and resemble immense horns or antlers. That these formidable outgrowths are really used as weapons is beyond question.

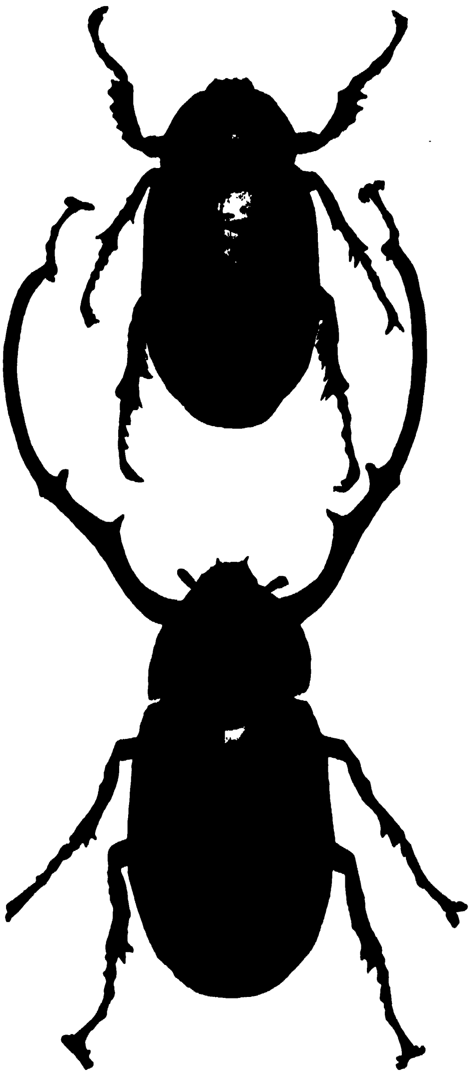


Photo by Harold Bastin

Some tropical beetles have specially developed forelegs for grasping their spouse should she prove coy

The writer once witnessed an exciting contest between two male stag-beetles. One of them was paying court to a female, when the second approached, and it became evident that trouble would ensue. At first there was no active hostility. Did the new-comer essay argument or cajolery? If so, the attempt ended in failure. Without more ado he opened wide his great jaws, rushed at his opponent, and (not without labour, the two being about equal in point of size) forced him backwards to a distance of more than a foot. Then began a most amusing tussle, the one beetle striving to return to his lady-love, the other balking him. Eventually the original suitor admitted defeat by turning tail and making off, while the victor marched in triumph to the fair cause of all the trouble, and began to court her in his turn.

Darwin mentions that male stag-beetles sometimes bear wounds from the huge mandibles of other males, but it seems doubtful whether these love conflicts are often carried to such direful lengths. Probably the weaker male usually gives place to his rival before serious damage is done, for the affair is one of honour, and it is to the interest of both parties not to push matters to extremes. Although we have very little definite information on the point, it is highly probable that all male beetles which are equipped with nipping horns, and similar appliances, make use of them to carry or drag the female to a secluded spot, where the happy pair may hope to escape further molestation by rivals. The huge Hercules beetle of South America has been seen to carry off his mate in this way. Other tropical beetles have specially developed forelegs for grasping their spouse, supposing she should prove coy and attempt playfully to run away.

Many insects are endowed with weapons, e.g. the formidable jaws of certain ants and the stings of wasps and bees—which enable them to resist attack. One of the strangest devices of this kind, however, is possessed by the little bombardier beetle. This insect is preyed upon by larger beetles of its own family; but when chased, the bombardier ejects an acid fluid from glands situated at the tip of its tail. This acid immediately vaporises on contact with the atmosphere, and looks like a tiny puff of smoke, while at the same time a distinct report is heard, reminding one of a miniature cannon. The discharge can be repeated several times in rapid succession, and must prove very serviceable in keeping the enemy at bay until the little artilleryman is able to find shelter beneath a stone, or in a crevice of the soil.

Photo by Harold Bastin

An Insect Artilleryman

The Bombardier Beetle is able successfully to resist a stern chase

The Highest Tunnel

How a Railway Tunnel Has Been Driven Through the Andes

EVER since the discovery of South America the great Andean chain of mountains, which runs from end to end of the continent, has formed a formidable barrier to intercourse between the nations inhabiting it. Indeed, it has actually been simpler for people living in the Argentine to make a long sea voyage in order to reach their neighbours in Chile rather than attempt to cross the natural frontier dividing them. But the proud Andes have now been subdued by the burrowing through them of a tunnel, the loftiest (of any considerable length) in the world. This is to be found on the Transandine Railway, which runs from Buenos Aires, on the Atlantic, to Valparaiso, on the Pacific, a distance of 888 miles. In ascending the Andes the track follows more or less closely the old Andean trail till it reaches the foot of the Cumbre Pass. Here, at an altitude of 10,500 feet above sea level, the summit of the mighty range of mountains is pierced by a tunnel just over two miles in length.

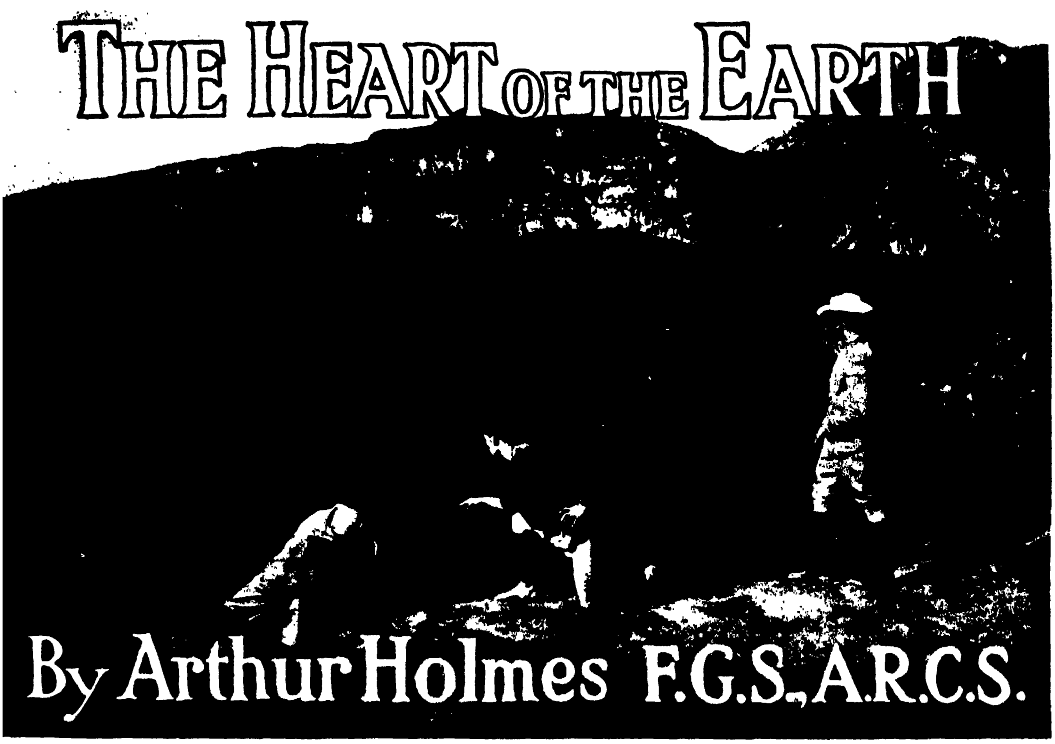
It was at once a difficult and arduous feat, necessitating the toil of an army of brave men for several years in a region of eternal snow and frightful blizzards. Indeed, this tunnel in the Andes lies 1,500 feet higher than the highest carriage road in Europe—that over the Stelvio Pass—and more than 8,500 feet higher than the Mont Cenis, St. Gothard, and Simplon passes. With the opening of the Panama Canal the commercial importance of this tunnel can hardly be exaggerated.

Photo: A. Streich, Mendoza

The Highest Railway Tunnel in the World

For ages the lofty Andes have proved a barrier to intercourse between the kindred peoples of Western and Eastern South America. Now easy railway communication has been established between Buenos Aires and Valparaiso through a tunnel, 10,500 feet above sea-level and 2 miles in length

II.—In the Underworld: Natural



THE HEART OF THE EARTH

By Arthur Holmes F.G.S., A.R.C.S.

Photo C. Ponting

The Crater of Aso San, Japan

Could we descend to the heart of the earth via this road, what should we find there?

Is the Earth's Centre Molten or Solid? The Latest Scientific Opinion

WHAT should we expect to find if, in a daring flight of imagination, we could make a journey through the heart of the earth?

Should we encounter a great cauldron of molten rock and metal underlying a thin and readily distorted crust, or should we find far within the depths a heavy metallic core, solid and rigid throughout?

It might seem at first as though the attempt to answer these bold questions were for ever doomed to failure. So far as actual penetration is concerned, we have merely scratched the surface, for the deepest mines and boreholes extend our range of observation downwards to only a little more than a mile.

If, then, our achievement has been so slight, how can we hope to know anything of the vast interior which stretches away for nearly 4,000 miles beneath our feet? Fortunately we have come to regard our planet as itself performing gigantic experiments, and from this new point of view the investigation of its internal architecture has rapidly advanced.

We are all familiar with the incessant ebb and flow of the tides, and everybody knows that the advance and retreat of the waters takes place in obedience to the enormous forces of attraction set up by the moon (and to a less extent by the sun). The same forces are ever straining and pulling at the land, and unless the earth were to act as a perfectly rigid solid, it too ought to rise slowly up and down. To have detected a tide in the solid earth is the great achievement of Dr. Hecker, of Potsdam. With two horizontal pendulums of exquisite precision, which he set up in a cool chamber excavated at the bottom of a deep well, he succeeded in measuring the heave of the earth as the moon passed overhead. As he himself says:

Drawn by John Gauld

Tides in the Earth

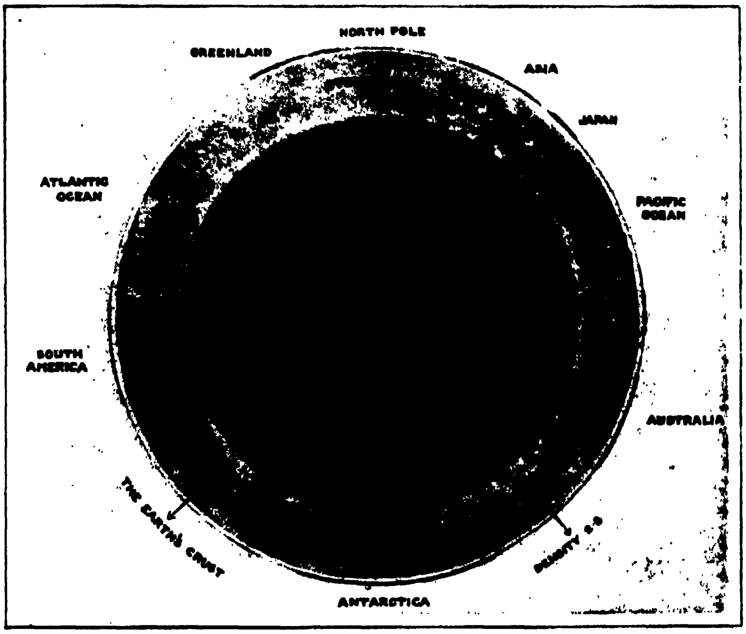
The moon raises tides in the solid earth, which rises and falls in response to the lunar attraction. The directions of the tide-raising forces are indicated by the arrows. London rises and falls half a yard every day

"There is something strange in the thought that a city like London with all its huge buildings is imperceptibly rising and falling twice a day through a distance of half a yard."

But Hecker did more than reveal to us this unfamiliar experience of every day; he also showed that the elastic flood tides which sweep round the earth are of just the height which the moon could produce if the earth consisted throughout of solid steel.

The same remarkable conclusion had already been deduced from the measured and calculated heights of the fortnightly ocean tides, and again from the fact that the earth does not spin about its axis quite steadily, but nods a little like a top which is not quite sound asleep. Because of this, the poles move round in a curve of about 22 yards diameter every 427 days, exactly as a yielding globe of steel would do, whereas if the earth remained unaffected by the enormous stresses which this nodding sets up, the curve would be completed in 805 days.

So far, all we have learned is that, as a whole, the earth behaves as though it were solid and constructed throughout of steel. But this is merely an average conception. The rocks which build up the earth's crust are obviously far less rigid than steel, and this demands that the interior must be very much stronger than steel in order to compensate for the outer weakness. Moreover, the mean density of the earth is 5·57, whereas the crustal rocks only average 2·7. It is therefore clear that if ordinary rock material were to persist throughout the earth, the weight of our planet would be reduced by half, and its resistance to tidal stresses would become dangerously feeble. These considerations make it certain that the internal core is exceedingly strong and very heavy, and from the earth's magnetic properties it is most probable that like the iron meteorites—the disrupted fragments of another world—the core is largely composed of iron.



Drawn by John Gauld

Section through the Earth's Heart

Beneath the rocky crust of the earth, 35 miles in thickness, there is a broad belt of heavier material to a depth of 900 miles. Within this spherical shell of stone lies the great metallic core

Although we cannot penetrate any distance into the earth, yet the geologist can detect and analyse the elastic waves which come to him from the focus of a distant earthquake through the heart of the planet.

An earthquake is caused by a dislocation in the earth's crust. The earth-waves set up by the sudden shock are of three types, and if a violent shock occurs, say, in Japan, three distinct kinds of tremors are received in England. One set creeps round the crust at a speed of nearly two miles per second. Another set, in which the material is alternately compressed and dilated, passes straight through the earth, and as soon as the waves penetrate to a greater depth than 35 miles their velocity rises rapidly to six miles per second. The third kind of wave twists and distorts the substance of the earth in a curious way, and beyond the 35 miles outer layer its speed becomes three and a half miles per second. Should it pass far down towards the centre it is again retarded, and averages only two and a half miles per second.

Now, a wave of distortion could not be propagated through the interior of the earth if the latter were in a liquid condition, and therefore if the interpretation of the wave is correct, we have absolute proof of the solidity of our globe. Further, from the velocities of the tremors at various depths it is found that the globe is built up of three concentric shells which differ markedly in density and stiffness. Beneath the rocky crust, a superficial layer of about 35 miles in thickness, there is a broad belt of heavier material—still made up chiefly of rock—which extends to a depth of some 900 miles. Within this spherical shell of stone lies the earth's metallic core.

II.—In the Underworld: Artificial

FIRES THAT NEVER DIE

by E·A·Bryant

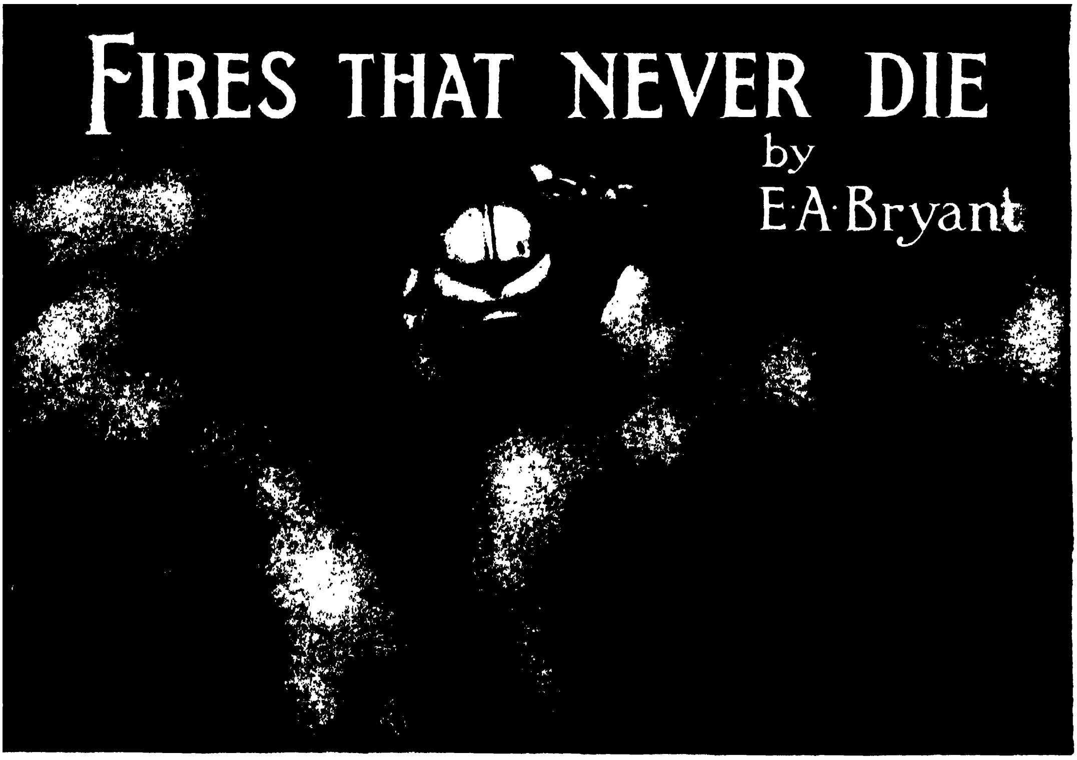


Photo by permission of Mr. K. Jacobson

How Coal Miners Work in Pits where Fires have Burnt for Generations

AMONG the fascinating schemes of one of our ablest scientists is one for the direct supply of power from the coal-mine to the factory, the railway, and the home. Instead of mining the coal and carrying it to a thousand depots, we are to burn it in the mine where we find it, to apply upon the spot the kindling torch which shall release from bondage the slumbering energy stored by the sun in a myriad prehistoric trees, now converted into coal. We are to transmute that bottled energy into electricity, and wire it from the pit-mouth straight to the user of power.

Of course it is but the dream of a savant, one of the visions that our young men of physics see. Were the project seriously entertained, the medium for experiment would not be lacking. We have our fires not made with hands, prepared for the trial. If the scientist would win boon from bane, there are many furnaces ready to his masterful hand. For, of the perils that menace our coal-fields, the fire that does not die is one of the most insistent.

Deep within the gloomy heart of the mine these sullen furnaces smoulder, from year to year, sometimes from generation to generation. Many pictures of subterranean peril rise to the mind of the novelist who depicts the scenes in which the miner's lines have fallen, but it is inconceivable to him, as to most of us, that in mines where no match may be struck, no naked flame permitted, fires stealthily eat their way along the seams, while men are toiling at an adjacent face. But the fires and the menace that their existence connotes are there, insatiable wolves at the door of industry and life.

A long-lasting fire in the workings of a colliery is not a subject of which we hear in the daily press. If every cupboard must have its skeleton, colliery owners prefer that their fiery one should not be unnecessarily advertised. Hence it comes as a surprise now and then to learn, from accident or other unexpected origin, that a mine of supposedly unblemished reputation has for an age engaged the unremitting attention of a host of fire fighters.

Staffordshire periodically has its panics when the unusual activity of hidden fires causes houses to topple, walls to crack and totter, tenements to become intolerable from the heat below. Now Staffordshire, with the many conflagrations which her mines conceal, normally faces with equanimity conditions which would terrify an area less sophisticated, but two or three times of late even Staffordshire has been shaken by events beneath her foundations. A few years ago the North Staffordshire Hospital for Infectious Diseases began slowly to sink, and there was unfeigned alarm, for the portion of the building affected contained at the time no fewer than a hundred patients. The building was certified well and truly founded, but it was slowly disappearing, like a jerry-built villa on shifting London clay. Experts, called to account for the mystery, had not far to seek. The hospital was established on a rich, unsuspected vein of coal, and that coal was quietly burning, eating away the foundations of the hospital resting upon it. Fifteen feet of burning coal underlay the building; and the fact that fifteen feet of fireproof brick was substituted for the incandescent stratum accounts for the existence of the hospital in security at Bucknall to-day.

Equally drastic methods have had to be employed, on two different occasions, for the safeguarding of the

The Fire Fighters

(Drawn by E. S. Hodgson)

The fire fighters were the most important men in the pit. Their first duty was to examine the walls of this imprisoned demon of destruction; to record the temperature and note fresh symptoms of eruption

When Fire and Water Meet

One night in 1898 the flooded River Tawd burst into a pit where there had been a fire for 25 years. When the water reached the fire a waterspout ascended the shaft of the mine. The greater part of the winding tackle was carried 300 feet into the air

Primitive Methodist Church at Darlaston, in the same county. The floor of the building was gradually subsiding, the walls were falling outwards. The first was taken up, and water enough to stock a reservoir poured in; the walls were newly buttressed. Burning coal beneath the building was again responsible. It is significant of the extreme tenacity of fires of this sort that, between the first and second subsidences at this spot, seven-and-twenty years elapsed. The fiery serpent had at the first essay not been killed, but merely scotched; when next it manifested itself it had moved from the rear of the premises to the front of the chapel. In ancient days, when superstitions were more vital than reason in directing human affairs, the pastors and masters of that little centre of religious activity would have had embarrassing theories to combat as to the origin of this consuming furnace.

After 27 Years

Let us, however, take a nearer view of these enduring fires of mysterious creation and perplexing continuity. Perhaps as dramatic a story as any is that which, a few years ago, brought the Tawd Valley Colliery, through fire and water, to an end. The Tawd Valley Colliery was a rich coal-field in Lancashire, a dozen miles or so from Liverpool. Over its surface coursed the Tawd, a petty stream unknown to our gazetteers. When the grandfathers of the present generation of Lancashire miners were boys, fire, following an explosion, took hold of an important working in the mine, and, defying all efforts at its extinction, threatened the destruction of the colliery. To avert this evil heroic measures were taken; the little Tawd was diverted from its bed and turned down the shaft of the blazing mine.

Unlike Napoleon's Old Guard, a colliery fire surrenders, but does not die. This fire surrendered to the full torrent of the river. But the remedy was wellnigh as destructive as the ill that it cured. The water did enormous damage in the mine, sweeping away stays and natural supports and playing havoc with the workings as with the owners' capital. When, therefore, fire recurred in 1872, it was found impolitic to repeat the remedy. Fire established itself fixedly in a thick seam of coal, and remained invincible. It burned for twenty-six years! This was no matter of

> "A little fire . . . quickly trodden out
> Which, being suffered, rivers cannot quench."

It was a great fire, deep-seated in a seam, to quench which they must have flooded the mine to its roof in a high-lying gallery. The owners dared not repeat the risk. They set themselves, therefore, to restrain and discipline the fire. They sought to besiege it, to cut off supplies of food and air, to starve it into surrender. They fought it for six-and-twenty years. Young men grew old in battling with the fire, and to the end it was not conquered. They built it in. They threw up massive masonry all round it, seeking to stay its progress deeper into the seam, and to keep air from enhancing the combustibility of the supply upon which it fed.

The effort was in vain, except in so far as it enabled the proprietors to keep nearly a thousand men at work, hewing coal from other parts of the mine, for over a quarter of a century. Slowly, invincibly, the fire ate on. It burst its restraining bonds, cracked the massive walls, drew in fresh air and life, took a firmer hold of the adjoining coal, roared a sullen defiance in the teeth of the watchers. Again and again they bricked it up; as often it broke through.

The Fire Fighters

The fire fighters were the most important men in the pit. The first duty of the day shift, the first duty of the men who came on to work through the night, was to examine the walls of this imprisoned demon of destruction; to record the temperature, to note new defects, fresh symptoms of eruption. The first duty of the manager at the board meetings was to read to the directors the story of the month, written by the fire below, to order new preventive measures, to deliberate upon some fresh method of insulating the peril. In spite of all, the fire continued gradually, inexorably, to make ground. Walls and buttresses continued to burst and shiver, and ever and again flames leapt through the blazing breach to light the gloomy workings. Each time the fire broke through they imprisoned it afresh within still stouter ramparts, until, when the end came, this subterranean city of fire was girt about by walls one hundred yards in thickness. The fire was unconquered to the last, so far as the engineers were concerned, but then, almost as swiftly as it had begun, the furnace was blotted out.

Fire and Water Meet

During all these years the men in the mine had worked between fire and water, fire in the pit, water coursing through the colliery yard overhead. There came a night in 1898 when the two elements met. Swollen by winter rains and melting snows from the distant fells, the little Tawd developed into a torrent, fierce, fast, and overwhelming. In days when "for the love of God" they burned the Lancashire witches, primitive colliers had mined the Tawd Valley outcrop near the banks of the stream; had sunk their small mole-tunnels as deep as they dared to go before shaft-sinking had come into being. Their little skin-deep galleries had long disappeared from external view, no one knew of their existence.

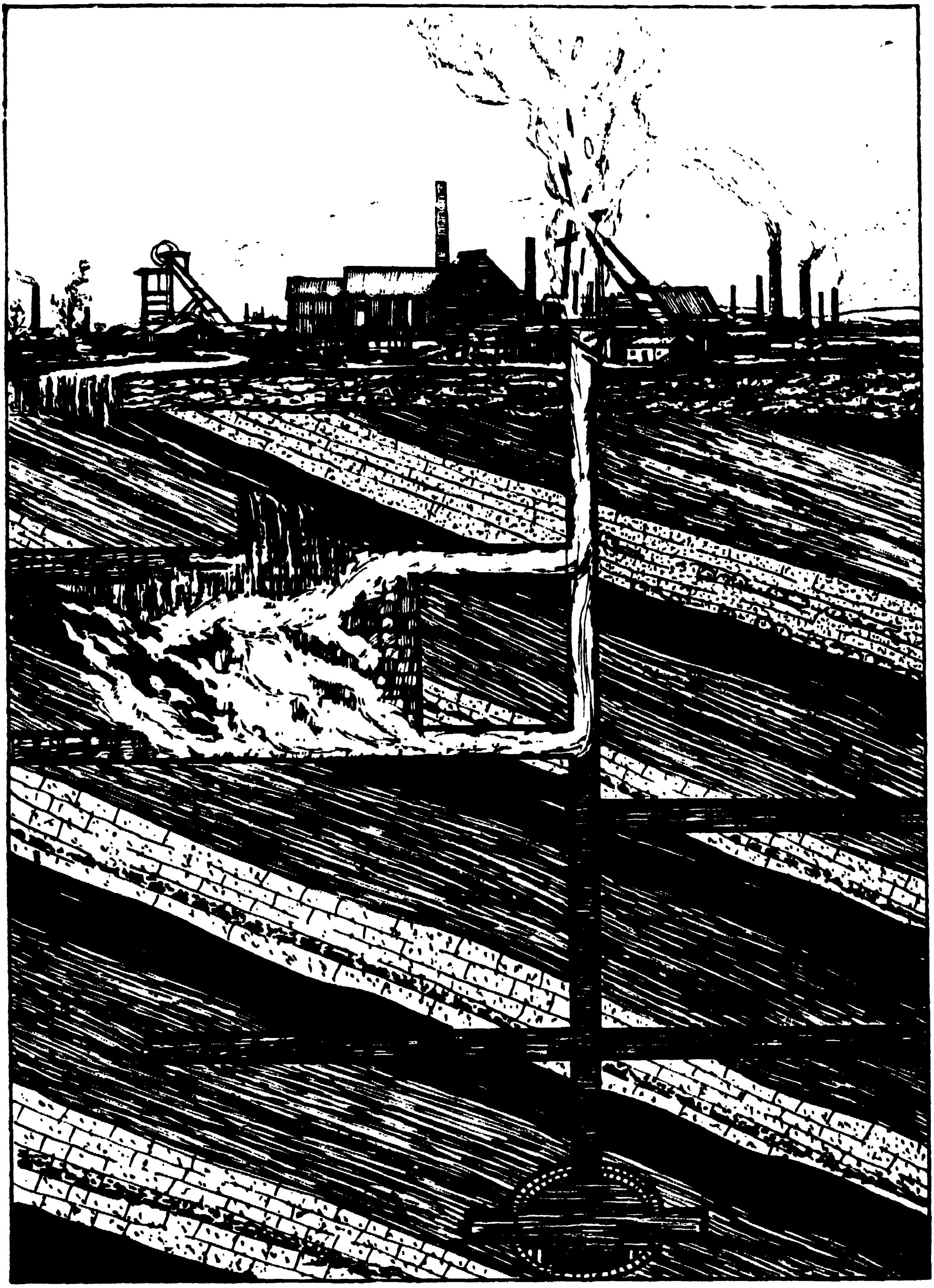
The river found them.

The lateral thrust of the angry torrent caused part of the bank to collapse. The little tunnels of the Middle Ages were laid bare, and the flooded river, impelled from its bed, rushed like a miniature Niagara through the opening, burst, by sheer weight and mass, through the thin uppermost gallery of the mine, and took possession of the pit. It was so sudden, so unexpected, that nothing could be done to combat the inrush. By a miracle of fortune it was the hour at which shifts were being changed. An hour later or an hour earlier and five hundred men would have perished.

The flood surged through the galleries, and those gathered about the pit-head waited for the effects of its meeting with the embattled city of fire. When the water reached it a waterspout ascended the shaft of the mine. The shaft was 490 yards in depth, but there came a rush of water and steam and debris from the shattered cage at the bottom, which, the watchers averred, carried the greater part of the winding tackle three hundred feet into the air. The fire, which had burned for a quarter of a century, was extinguished. But so was the mine, commercially. The water filled it; to have put down the pumping plant necessary to clear it and repair the ravages of the flood would have cost more than the life of the mine was worth. So, with water in every gallery and five-and-twenty ponies in the workings, and two men dead at the bottom of the shaft, the end of the story was tragically written. It was only then the world knew that the Tawd Valley Colliery had ever had a fire burning at its heart.

Some Other Instances

The story once told, seemed to bring echoes from many quarters. One such sprang immediately from the Whitwick Colliery in Leicestershire, where, though known only to the local few, a fire had for a quarter of a century defied the wisest efforts of the managers of the mine. The attempts to confine the living fire within a vault failed in the end, and thirty-five lives paid the penalty. Next there came to light the tale of a fire in an Ayrshire mine which was still making steady progress after half a century's existence; and of another in a Warwickshire colliery which was slowly eating its way towards Birmingham; while yet another, in the Walkden (Manchester) Colliery had run its course of



Section Through a Coal Pit

(Drawn by John Gauld)

Section of a mine showing how the little River Tawd (top left side of picture) burst through the thin upper gallery of a mine and reached the bricked-in fire. The junction of fire and water caused a rush of water, steam and debris to burst from the shaft. The fire was extinguished, but so was the mine

a generation and expired simply because there remained nothing further to burn.

They have a blazing mine in Aveyron, France, which is known as the "burning mountain of Montet." Intermittently it gives forth a pillar of cloud by day and a pillar of fire by night, and is then commonly mistaken for a volcano in active eruption. Clackmannan, too, had its imitation volcano, but this lasted something like forty years. Some day a man who knows the story will probably accord it a lurid place in a novel. It began with all the appurtenances of drama: a disused coal shaft near Stirling, out on a blasted heath, deserted through the proprietors—the South Sauchie Colliery Company—having sunk a shaft into the same seam at a more favourable position.

The shaft which the mine-owners despised became the headquarters of a gang of illicit distillers, who found in the old pit the very place for their operations. They set up their still in the mine and drove a thriving trade, until fire, spreading from their small furnace, fastened upon the coal and frightened them from hiding.

An Illicit Still

The fire quickly got a good hold, and its flames, issuing from cracks in the ground as well as from the shaft, lighted at night time the whole countryside. So began the "burning waste of Clackmannan." But the fire did not remain at its starting point in the old mine. Fanned by currents of air in the workings, it advanced rapidly into richer areas, burning on from year to year with irresistible fury until eventually it embraced an entire seam of coal twenty-six acres in extent. Every known fire-fighting device was tried, but ineffectually, and at last Lord Mansfield, the owner of the coal-field, acting upon the advice of the highest engineering authority, decided to wall in the fire, and so exclude air from it. The wall, which was of mud, took five years to build, and cost £16,000. The work was dangerous and difficult, for the heat in the mine was terrific, and the perils from subsidences of roof and the rising walls incessant. At last the rampart was completed—and found wholly useless.

After a generation Sir Goldsworthy Gurney, the man who had put the first successful steam car on the roads, agreed to try a method of his own. The prime mover was his infallible steam jet, with which he drove his car, improved the steamship, created the blast furnace, cleaned out sewers, did nearly everything in fact.

He erected a furnace at the pit mouth, installed a number of pipes in the mine, and penetrated the wall around the fire to enable him to reach the glowing furnace within. Then he got up steam from his boiler, and by its aid forced down under high pressure large volumes of mingled carbonic acid and nitrogen. In the course of a day or so eight million cubic feet of gas filled the mine. The shaft was closed down, and as far as possible the mine was completely sealed, and so remained for three weeks. The absence of free oxygen from the mixture extinguished the fire; then steam and afterwards cold damp air were introduced, so that when a party of investigators at last entered the mine, they found the fire of forty years no more, and the mine cool and practicable.

Happily not all these fires are so destructive as those indicated. There is one burning at this hour which cannot be considered as aught but a public benefactor. Cracks and subsidences of buildings at Haselbach, near Altenburg, Germany, during the present year, led engineers to make borings in the subsoil. They found fire, fifteen feet down, in virgin deposit. But they also found coal, whose existence had never been suspected. Haselbach is built on part of a vast coal-field, and that coal-field is on fire. The subsiding buildings have revealed a sort of treasure trove of a colossal snapdragon type. The plums are there for the snapping, but the hands to gain them must be impervious to flame.

Blessing in Disguise

III.—On the Sea : Natural

Sea Water

Remarkable Facts about the Element which Covers Five-Sevenths of the Total Area of Our Planet

By HOWARD TRIPP, M.A., Ph.D.

FEW things appeal more to the human imagination than the study of the infinitely great and of the infinitely small. Not only do the heavenly bodies and the immensity of space fill our finite minds with a feeling of awe, but the infinitesimal organisms which frequent the earth, the air and the water awaken in no less degree our wonder and admiration.

The surface of our planet, which is but a speck in the ocean of space, is covered to the extent of five-sevenths by the sea, the depth of which varies from a few hundred feet, as for example in the English Channel, to thirty or forty thousand feet, such as we find in parts of the Atlantic Ocean. The volume of the water is so enormous that the immersion in it of a whole continent would probably only raise its level by a few inches! Estimates of the total quantity of sea-water vary from twelve to five hundred million cubic miles.

Such calculations are very conjectural, and any approach to accuracy is negatived by the fact that the bottom of the sea is not uniformly flat, and that its contour is continually altered by volcanic action. Soundings in deep ocean have revealed the existence of prodigious mountain chains, of deep precipices, of yawning chasms, and of multitudinous plateaus and valleys.

What imposing spectacles would meet the gaze of the submarine explorer could he only wander about the depths of the sea as easily as on the surface of the land!

Photo: T. C. Hepworth

Beachy Head

The depth of the sea varies from a few hundred feet in the English Channel to thirty or forty thousand feet in parts of the Atlantic Ocean

Except for the fitful glow of some passing phosphorescent organism, the depths of the ocean are for ever enshrouded in impenetrable darkness; and even could we provide our explorer with light and with air to breathe, he would be crushed and crumbled into atoms by the enormous pressure which obtains at such depths. The true bed of the ocean is covered with organic ooze and red clay. There is no plant life below about 700 feet, but there are apparently no limits to the existence of animal life, which is most abundant in the uppermost and lowest regions. The corpses of the animals fall to the bottom and form the chief constituent of the ooze.

The Colour of the Sea

Clear sea-water in thin layers is colourless, in thicker layers green, and then blue. White objects immersed in sea-water appear green, but become more and more blue the deeper they descend. The reason of the blue colour is that the water easily absorbs the yellow and red rays. All deep and clear seas are blue. The renowned azure tint of the Mediterranean is not confined to that sea, but is met with in tropical, temperate, and frigid zones. The North Sea is green because it is not very clear, comparatively shallow, and the reflections of the sandy bottom mingle with the natural tint. But the colour of the ocean is also conditioned by the presence in it of minute suspended particles of mineral matter, and the freak colouring of certain waters has been traced to the presence of living organisms. Thus the colour of the Red Sea is due to myriads of microscopic algæ of that colour. In various parts of the globe, white, yellow, brown and orange seas have been observed.

The clearness of the sea is very great in some parts. In the Indian Ocean, near Mendora, corals can be observed at a depth of 25 fathoms. Columbus records the intense transparency of the Caribbean Sea, where the water was so clear that the boat appeared to float in the air, and on the clean, sandy bottom, thousands of coloured fishes were plainly visible.

The greatest depth of vision recorded is 252 feet in the Black Sea. But if this is the limit to the penetrative power of ordinary light rays, the so-called actinic rays, viz. those which affect a photographic plate, penetrate far deeper. Experiments made between Corsica and the Riviera showed that a photographic plate was affected at 1,500 feet, but not at 1,575.

Everyone knows that the sea contains dissolved salt, but few are aware that a large number of other substances are always present in it. In fact, no less than thirty-two of the chemical elements are to be found in it, in various forms and combinations. There is no doubt that gold is one of these elements, but the proportion of it is so exceedingly small, and the process of isolation so intricate, that it is safe to say that the production of gold from sea-water is commercially infeasible.

The amount of salt and of other solids present in sea-water is by no means constant. The Atlantic Ocean contains on the average 3·6 parts of dissolved matter per 100 parts of water; the Mediterranean, 3·8 parts; the Baltic 0·5 parts; and the Dead Sea 22 parts.

The Dead Sea

Readers of Kinglake's "Eothen" will remember his experience of bathing in the Dead Sea. The taste of its water was detestable, its buoyancy was so great that he found it very difficult to swim, his body being raised so much in the water that his stroke was baffled. After his bath he took some time in regaining the shore, and when about to dress he noticed that his skin was thickly encrusted with salts! About two-thirds of the dissolved salts consist of common salt, the rest being composed chiefly of chlorides of potassium and magnesium, and sulphates of calcium and magnesium.

The presence of the last two substances makes sea-water so very "hard"; washing in it is practically impossible, and it can only be softened by the addition of chemicals. We have all experienced the difficulty of drying clothes that have been immersed in the sea. This is due to the magnesium salts, which obstinately retain water, and which, after drying, re-absorb it from the air. For the same reason the table salt becomes damp when there is much moisture in the air. Certain specially purified table salts remain permanently dry because the magnesium compounds are removed in the process of purification.

When salt water is evaporated to dryness the residue consists of all the substances that were previously dissolved, and is known as " sea-salt." If the evaporation is only partial, small cubical crystals of salt separate on cooling, and, on further concentration, the other solids crystallise out in turn. These solids are brought into the sea by the rivers, which have obtained them from the soil. Once in the sea, the dissolved solids are trapped, the evaporation of the water by the sun's heat having no effect upon them. Inland seas and lakes, which have no immediate connection with the ocean, are thus noticeably becoming more salty.

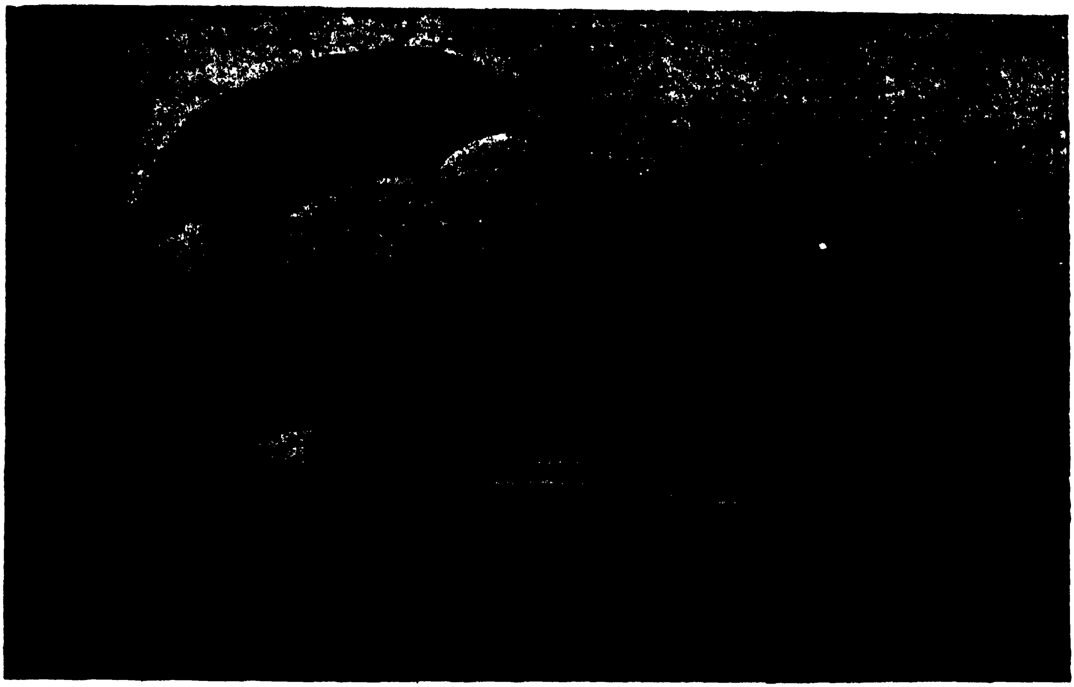


Photo: American Colony, Jerusalem

Floating in the Dead Sea

Its buoyancy is so great that it is very difficult to swim, one's body being so much raised in the water that one's stroke is baffled, but floating is delightful

The atmospheric gases—nitrogen, oxygen, and carbonic acid gas—are dissolved by the sea from the air, and play an important part in animal and plant life under the surface. The amount of oxygen—which the fishes breathe—and of nitrogen, is found to get less as the depth increases, but the carbonic acid gas increases with the depth, and is usually greatest near the sea-bed where animal life abounds.

Another interesting feature of sea-water is its temperature. Owing to water being a bad conductor of heat, its temperature is always more equable than that of the air or the land. Whereas the surface of the land in tropical countries is frequently heated to 129° F., the ocean has not been known to rise above 87° C. Sea-water has a high specific heat, in consequence of which, and of its great depth, its temperature is only very slowly raised or lowered. In the vicinity of the Equator its temperature varies between 82° and 83°, but the warmest part of the ocean is not at the Equator itself, but along two parallel zones to the north and south of it. In the Polar Seas the water is always warmer than the land and the air.

The Ingenious but Clumsy Outrigger Canoes of the South Seas

Amazing Survivals of the Time when Man First Used the Deep as a Place for Locomotion

WHEN or how in the dawning of man's history he first discovered the possibility of utilising the water as a place of locomotion, not merely for himself, but for his belongings, is a profound mystery, and likely so to remain. But what is peculiar and, I think, unique amongst the artificialities of man is that to-day, when invention has developed an *Aquitania*, an *Imperator* and a super-Dreadnought, the least observant traveller may find, not in museums, but actively employed, queer craft whose development has not progressed since that hazy century B.C. when they were invented. Foremost among these are the inflated skins which still do service in Northern India.

And what is stranger still, but useful as showing the static quality of mind possessed by some races, these vessels may be seen side by side with the latest development of the marine architect's idea, as, for instance, on the Coromandel coast. Can anything be more striking than the contrast between the two or three rough logs of the native fisherman, which, seized together with coir string, support him during his long night's toil at sea, and the modern P. & O. or B. I. steamship at anchor within the Madras breakwater, discharging her cargo with electrically-driven cranes and weirdly illuminated by electric light?

The well-beloved South Sea Islands can and do furnish many examples of the queerest of queer craft. Of course, they

The Portable "Boats" of India

In Northern India the natives still follow the practice depicted on ancient monuments of carefully stitching up the skins of bullocks and other animals which they can use as boats when needed. The illustration shows natives inflating these skins preparatory to launching them for the crossing of the swift-flowing River Sutlej are all of the dug-out or burnt-out species, the Kanaka mind refusing apparently to contemplate the possibility of braving the ocean waves in a vessel of woven leaves, such as Moses was launched in on the Nile. And, of course, they are handicapped by the absence of pitch, although they do use a kind of "chunam," or lime cement, for caulking purposes in their more elaborate vessels. For the benefit of those folk who always seem to imagine that the untutored native instinct works as unerringly as does that of birds, and beasts, and fish, I would like to say that all the aberrant craft one may see in various South Pacific groups are obviously the attempts of unhandy workers.

Photo: Underwood & Underwood

Reef Island Canoes at Santa Cruz

Lack of suitable material with which to carry out ideas has been responsible for the development of such queer craft as this

Canoes, that is, dug-outs of every shape and size up to the limit of the tree trunks available, may be seen, some more like a dish-cover than anything else, and some handsome enough to be models for the most modern naval architect, if he could afford to follow them. But they are all mightily interesting as showing how desperately the human mind strives for certain ideals when confronted by the difficulty of efficient navigation at sea.

Lack of suitable material wherewith to carry out ideas has been responsible in many parts of the world for the development of queer craft, chief among which, I think, we may place the rafts of jars on the Euphrates and Tigris, the inflated skins pictured on ancient monuments, yet in use to-day, and the straw-built balsas of Peru. For man fights hard with his environment, and in the struggle makes use of some strange tools as well as materials.

It is not until we come to the great mysterious Empire or Republic of China, though, that we are met with an astounding set-back. I firmly believe—and there are very many cogent reasons for so believing—that the dawn of navigation first broke in China; yet marine development in China stopped at the junk, than which it is utterly impossible to conceive

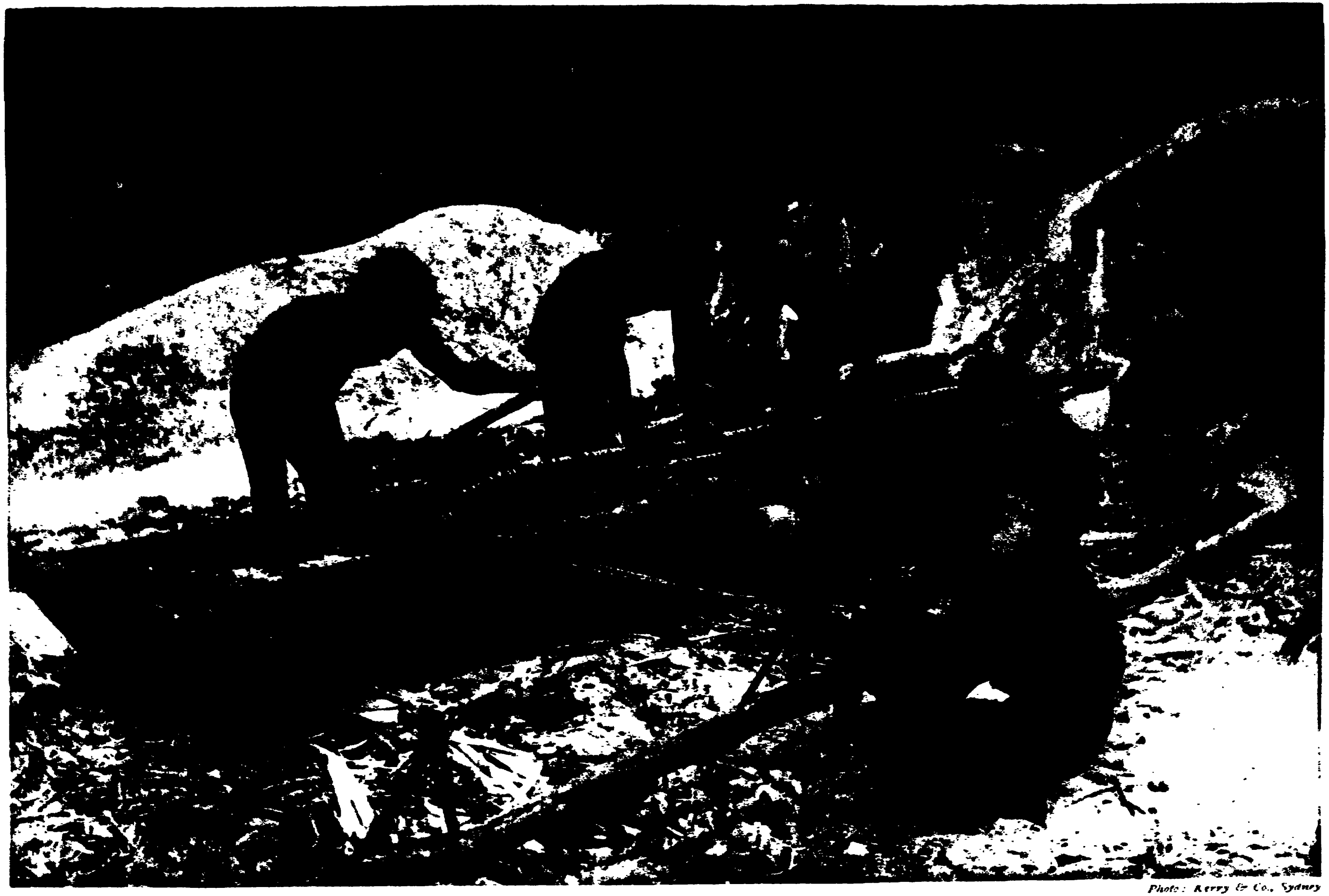


Photo: Kerry & Co., Sydney

Australian Aborigines Making a Canoe

It is quite a mistake to suppose that untutored instinct teaches natives to make boats as skilfully as birds make nests. Most South Pacific craft are obviously the attempts of unhandy workers anything queerer. Indeed, I have heard passengers remark on seeing one for the first time:

"It is really true, then! There are such things still in existence, and it was not a great joke that all the books and illustrators were having at our expense."

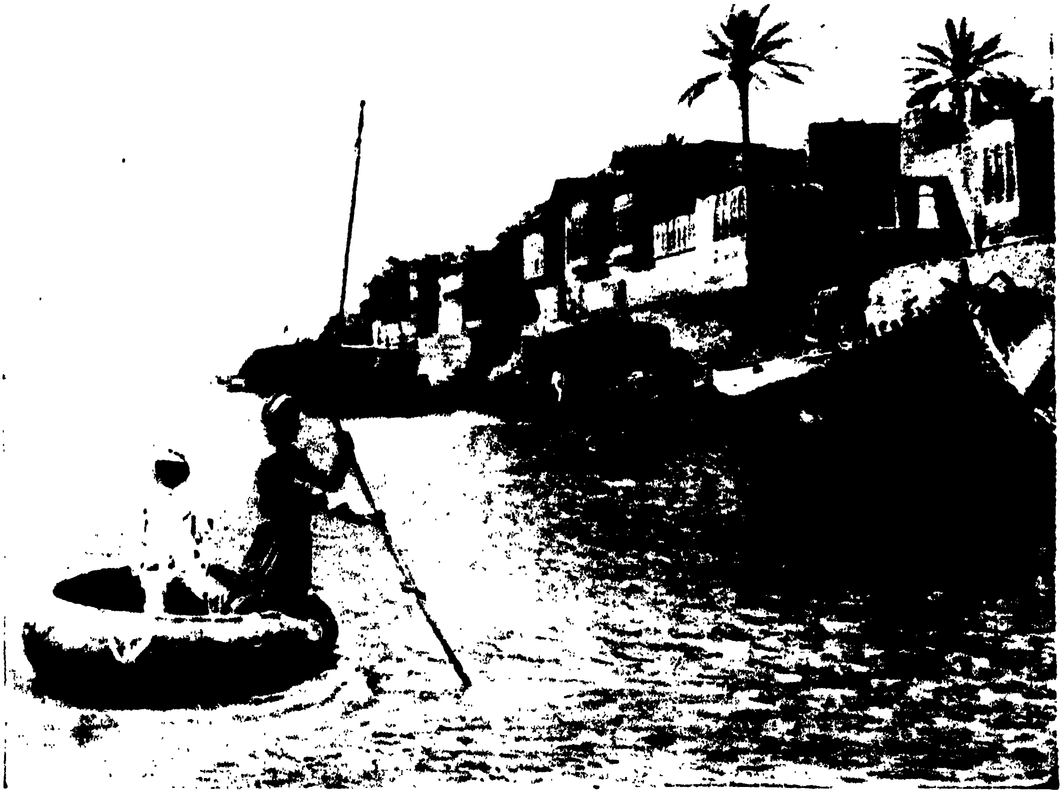


Photo. Underwood & Underwood

Crossing the Tigris at Bagdad

Among the most curious of craft are the jar-like vessels still in use in the East. In his struggle with environment man makes use of strange materials

It is all the more wonderful when you have seen a Chinese engineer at work, when the marvellous adaptability of the Chinese has been practically exhibited to you. You feel hardly able to credit the evidence of your own senses that such people can endure this fantastic erection, high where it should be low, and low where it should be high, with wooden anchors weighted with big stones, with ropes of twisted bamboo, sails of the same, decks laid with the same, vast, unwieldy rudders needing a dozen men to manipulate them, and, most fantastic of all, perhaps, a huge staring eye painted on either bow, because no vessel can otherwise see to navigate!

Yes, after millennia of experience in navigation, such quaint monstrosities are still constructed, still used in China, and what is perhaps more marvellous still, though not exactly germane to our subject, the men who handle these extraordinary vessels do so on the same principles as did their ancestors scores of centuries ago.

In fairness, it must be admitted that many of the queer craft still extant—whose lower part is a burnt-out log, dubbed neatly by the most primitive tools on the outside, whose upper works are *sewn* on with coir string, and whose equilibrium cannot be maintained without a great spar suspended at the end of two outriggers—are beautiful in outline and graceful in their movements. Of such are the fishing canoes of Ceylon and the outrigged canoes of many a South Sea group. Their queerness does not consist in their appearance, but in their utter, hopeless unsuitability for use. Neither as passenger bearers nor cargo carriers have they any reason to exist, yet exist they do, because with the world's best models at hand, the native canoe builder seems unable to tear himself away from the designs handed down to him from an immemorial past.

In order that we may not be too conceited, I would like to say that some of the most modern ships are queer craft undoubtedly as far as their appearance goes. They are just huge steel boxes with hardly enough bow and stern to give them a faint resemblance to a ship, and a double row of cargo derricks, among which the small squat funnel is hardly noticeable. Seen broadside on, the whole contraption looks like a length of dockside broken away with all its cargo gear complete, and the sight makes a sailor wonder whether the ocean has ever seen a queerer-looking craft.

Asleep in the Deep

The Marvellous Cradles Fashioned by Certain Fishes

By N. F. WATSON

"FOXES have holes, and birds of the air have nests," a fact stated in terms as old as the Christian era. But there are homes, not made with hands, in the waters, where none but the trained observer dreams of finding them. It is one of the strangest of natural phenomena that home-making reaches its highest development, not among the animals physically and mentally most nearly allied to man, nor among the splendid beasts, carnivorous and herbivorous, which rank next to him in power and dominion, but in phases of life among the lowliest in mental organisation, among the birds, the insects, certain of the water-born land-dwelling animals (the amphibia)—and the fishes. For there are those among the dwellers in the deep which command a very high place in the company of geniuses of the nursery.

In our ponds and ditches, and in our coastal waters, may be found a great natural marvel, the sub-aqueous palace of the stickleback. The male of the fresh-water species is architect, builder, and nurse. He is a weaver of great skill, seizing pieces of fragile floating vegetation—grasses, straw, parts of growing plants—and fashioning the neatest of nests, through which fresh water can be easily forced. His sole implement is his well-armed little mouth, and with this he fashions a home that would not disgrace a bird. Instead, however, of being held in position by stout supports, this nest, delicate and yielding, is merely a floating cradle, which a rough wave would crush. To his completed dwelling the successful builder invites a female of his species, lures, or even drives her in, and refuses to let her depart until she has deposited her eggs. A second and even a third young bride may be honoured with a like invitation or command. Thereafter the solicitous sire keeps watch and ward over the nest, fanning vigorously at times with his fins to stimulate a current of fresh water through the nursery, so that the eggs may be continuously supplied with oxygenated fluid.

The fifteen-spined stickleback of the sea is a still more notable craftsman, for he not only weaves, but spins—weaves his nest of growing seaweeds, then spins a glutinous thread which hardens into a tough hawser, securely binding the nursery fabric in position. This is a notable fact, for although silkworms, caterpillars, spiders and mussels spin, only one backboned animal is known to possess a similar gift, and that is our little sea-going stickleback — half a foot of unadulterated courage and ingenuity.

The Three-Spined Stickleback

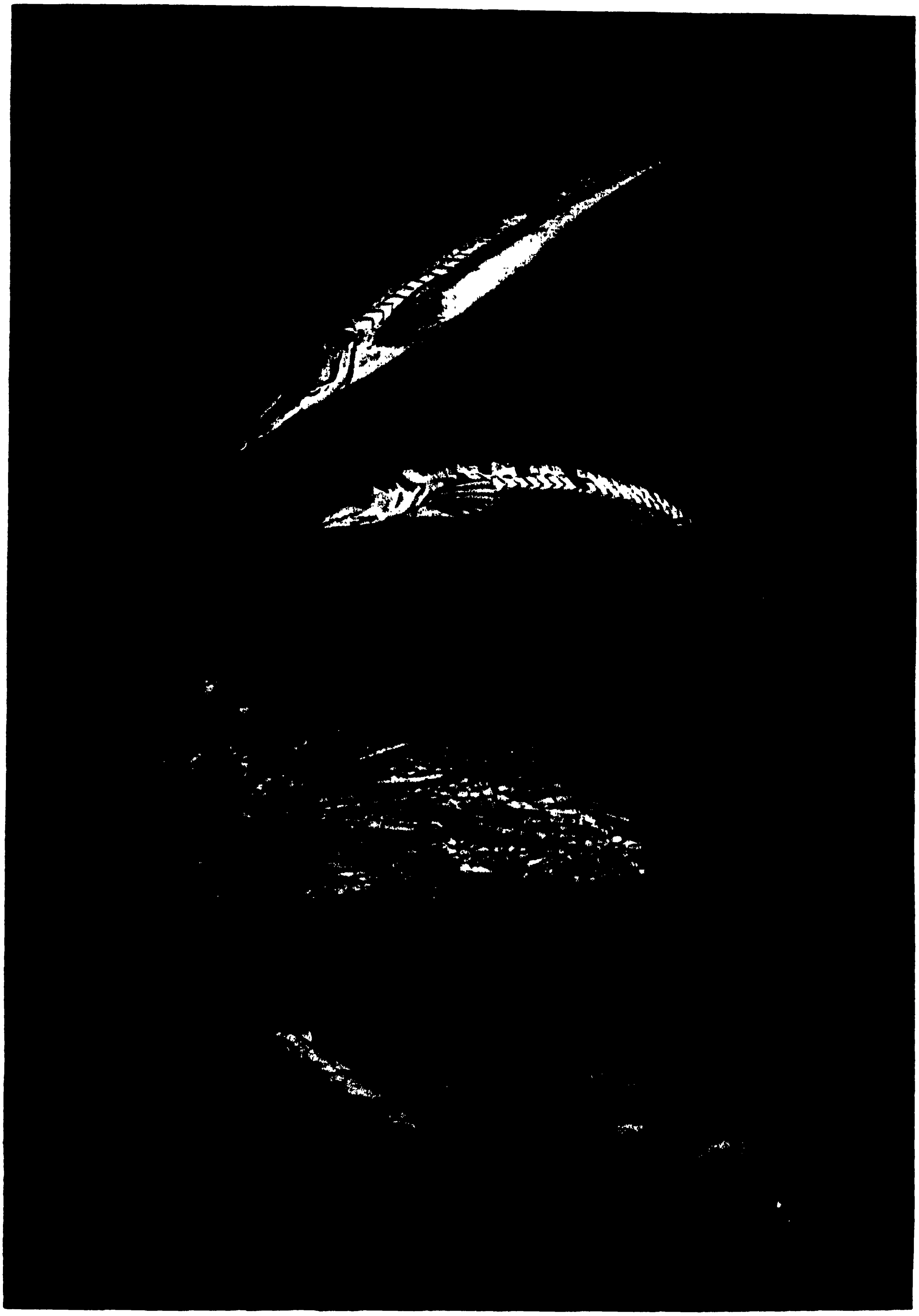
The male of the freshwater species is an architect of great skill. He not only builds but assiduously guards his nest

Tropical America has an ancient armoured type of fish belonging to the *Siluridæ*, known as the hardback, which excels the stickleback as a builder in an important particular. Its nest, of grass-blades, straw and leaves, demands of the young an early acquaintance with atmospheric air, for the nursery is fashioned, not actually beneath the water, but in a muddy depression just above the surface. This unique habit matches the performance of the adult fish, which, when the water of its original habitat runs low, cheerfully climbs the bank and stumps off on its fins to the nearest watercourse which is better supplied—but of this later.

We reach a further difference of structure in the incubating establishment of the American bowfins. These are large fish, four feet in length, and from 20 lb. to 80 lb. in weight. The male deliberately makes a clearing in the reeds and rushes, biting through the thick stems in order to effect a circular clearing, from which all debris is carried away, so that the ova may have above them a clear space of water in readiness for the advent of the young, which may number from hundreds to thousands.

Remarkable builders are found among a famous group of African fishes, the *Mormyridæ*, in which we discover very primitive characteristics associated with a significant development of brain substance. In this family is the eel-like gymnarchus, a fish six feet and more in length, with highly efficient teeth, with which it cuts a mass of vegetation and constructs a veritable ark, a nest which floats, bearing its treasury of innumerable lives-to-be, while the diligent male swims vigilantly in attendance, ready to do instant battle for their safety. These unique cradles measure four feet in diameter, and are guarded by walls eight inches in depth. In them the young fish safely pass the first three weeks of their existence.

The variety of fish nests is surprisingly large, considering that these citizens of the deep are generally regarded as being totally



Fifteen-Spined Stickleback of the Sea

(Drawn by E. H. Fitchew)

This remarkable fish not only weaves but spins—weaves his nest of growing seaweed, then spins a glutinous thread which hardens into a tough hawser, securely binding the nursery fabric in position

devoid of all parental care for their young. Here we need note only a couple more striking examples. One is the strange nursery of the cichlid, a fish common to the warm waters of both the Old and the New World, yet of totally distinct genera. Male and female make a nest in the sand by the shore, where the female deposits her eggs for fertilisation by the male. Then she takes the ova into her mouth, retaining them there until the young have completely developed, and are able to take care of themselves. Certain of the cat-fishes also have this habit, but here the male is the living incubator. He does not feed during all the period of hatching, and his devotion extends to the infancy of his youngsters, which, if menaced by danger, swim into his mouth, and there find safe asylum until the peril is removed.

Photo by F. Martin Duncan, F.R.P.S.

Sticklebacks at Home

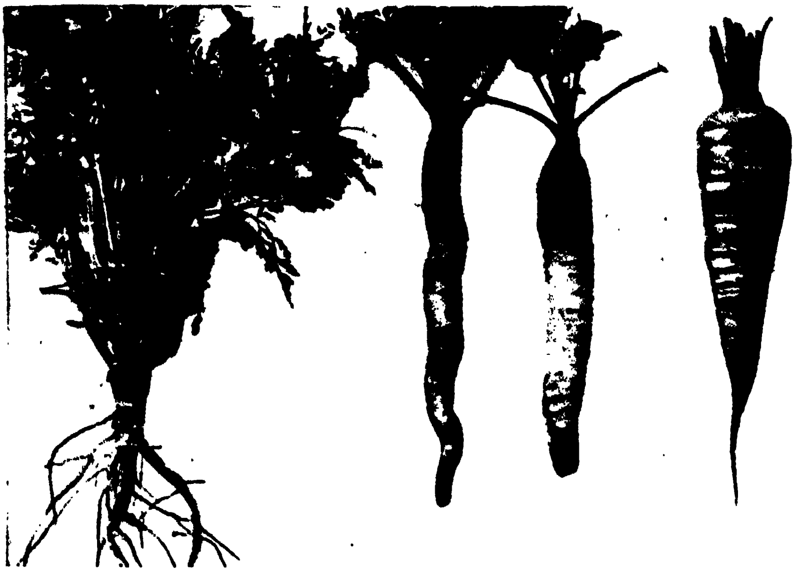
Observe the nest in the top right hand corner

Perhaps the most astonishing example of fish cradles is that which has been reserved for the last. This is the home of the young paradise fish, commoner as a domestic curiosity in China and Cochin-China than is the acclimatised gold-fish in Europe. Here the parent fish evolves his nursery from his own internal economy. He blows a number of air-bubbles, and cements them together by means of a glutinous fluid secreted from the lining of his mouth. And in that strangest, most beautiful of fairy-like abodes, the young paradise fish first see the light of day. They quit their castles of air to seek the guardianship of their sire, who guards them with a devotion and assiduity which would do credit to the best of worker bees or the most solicitous of nursing ants. Man's counterpart in the woods—the terrible likeness of the lord of creation, the anthropoid apes—cannot match the wonders achieved by these humble vertebrates, whose homes are in the unmapped waters.

Photo: W. S. Berridge, F.Z.S.

The Great Pipe-fish

The male Pipe-fish is a model parent, for he hatches his young in a pouch on his own body



Stages in the Modern Carrot's Evolution

The gardener of a generation or so ago would hardly recognise the carrot of to-day

New Plants for Old

How Man has Improved on Nature and Transformed Insignificant Plants into Splendid Blooms

By S. LEONARD BASTIN

Author of "Wonders of Plan

THERE are few more wonderful things in this twentieth century than the control which men have acquired over Nature. Perhaps the most startling instance of this is to be seen in the marvellous developments in the world of vegetation. It is indeed no exaggeration to say that the present race of plants would be hardly recognised by the gardener of a generation ago.

It is interesting to consider a few modern flowers and to compare them with their prototypes. Certainly one of the most singular examples is that of the sweet pea. Now we do not have to go very far back to find the time when this favourite flower was quite insignificant; the blossoms were small, poorly coloured, and few in number. Even ten years ago the sweet pea was quite small when compared with the splendid blooms of the present day. Of course, the cultivation of the rose is very old, although it is likely that the ancestor of the plant, as we know it, was a small pink species to be found in Eastern Europe. But within the last twenty years or so roses have been improved enormously; the graceful blooms and delicately coloured petals are very distinct from the cabbage-like flowers of our forefathers. It would seem, however, that the rose is beginning to suffer from over-cultivation, for, sad to say, the new varieties show a tendency to lose their scent. Some of the most exquisite forms are entirely without fragrance.

Fruits and vegetables, too, have shared in the wonderful advancement. There is little doubt that the forerunner of our fine strawberries was the little wild species which grows all over the temperate world and is common enough in our woods. It seems difficult to believe this, when one compares the wildling with a large and finely flavoured modern variety. Even more striking is the case of the carrot. Now, although it is believed that this vegetable has been cultivated for a very long time, it is only recently that the root has been properly developed. The carrot which our forefathers grew had a small root of uneven shape. But the skilful plant breeder has altered all this and has given to the world a carrot which produces a large and shapely root.

Photo by S. L. Bastin

The Modern Rose and its Ancestor

The cultivation of the rose is very old. The ancestor of the plant as we know it was a small pink species found in Eastern Europe

It is not an unnatural question to ask how these marvellous changes have been brought about. Of course, the simplest mode of improving a race of plants is on the following lines: The seeds of a certain plant are sown and, as these grow up, flower and bear fruit, they are carefully examined. The poor and undesirable types are destroyed, and only the best forms are retained. The seed from these alone is saved, sown again, and the process of selection repeated.

The modern plant breeder is far more ambitious. He has in mind a special type of plant which he desires, and he strives to attain the end by a very delicate method. This consists of crossing different types of the same kind or of a nearly related plant. The work is fascinating beyond description, and its very element of uncertainty makes it doubly alluring. Suppose, for instance, that the gardener has before him two nearly related plants. One produces small blossoms of an intensely brilliant hue, the other large flowers, but of a poor colour. Now the idea is to produce a plant which will bear good-sized blossoms with a good bright tint. With a camel-hair brush the plant breeder takes some of the pollen from one flower and, with extreme care, transfers it to the stigma of the other.

Next, he must take some precaution that the newly fertilised bloom is not visited by bees or any other insects. These energetic little creatures might bring some pollen from other flowers, and so upset the cross. It is customary to surround the flowers with muslin, so as to protect them from the unwanted visitors. When the plant which has been cross-fertilised sets seed, these are carefully preserved. In due season the seed is sown, and if all has gone well the breeder gets the flower he desires, although the processes of selection and hybridising may have to be repeated several times. Of course, there are many slips 'twixt the cup and the lip in this business. Still, the matter has been carried to a successful issue in hundreds of cases. About fifty years ago the gloxinia was a plant producing a small pendulous flower. The plant breeder set out to make the flower erect, and also enormously to increase the size of the blossom, with amazingly successful results.

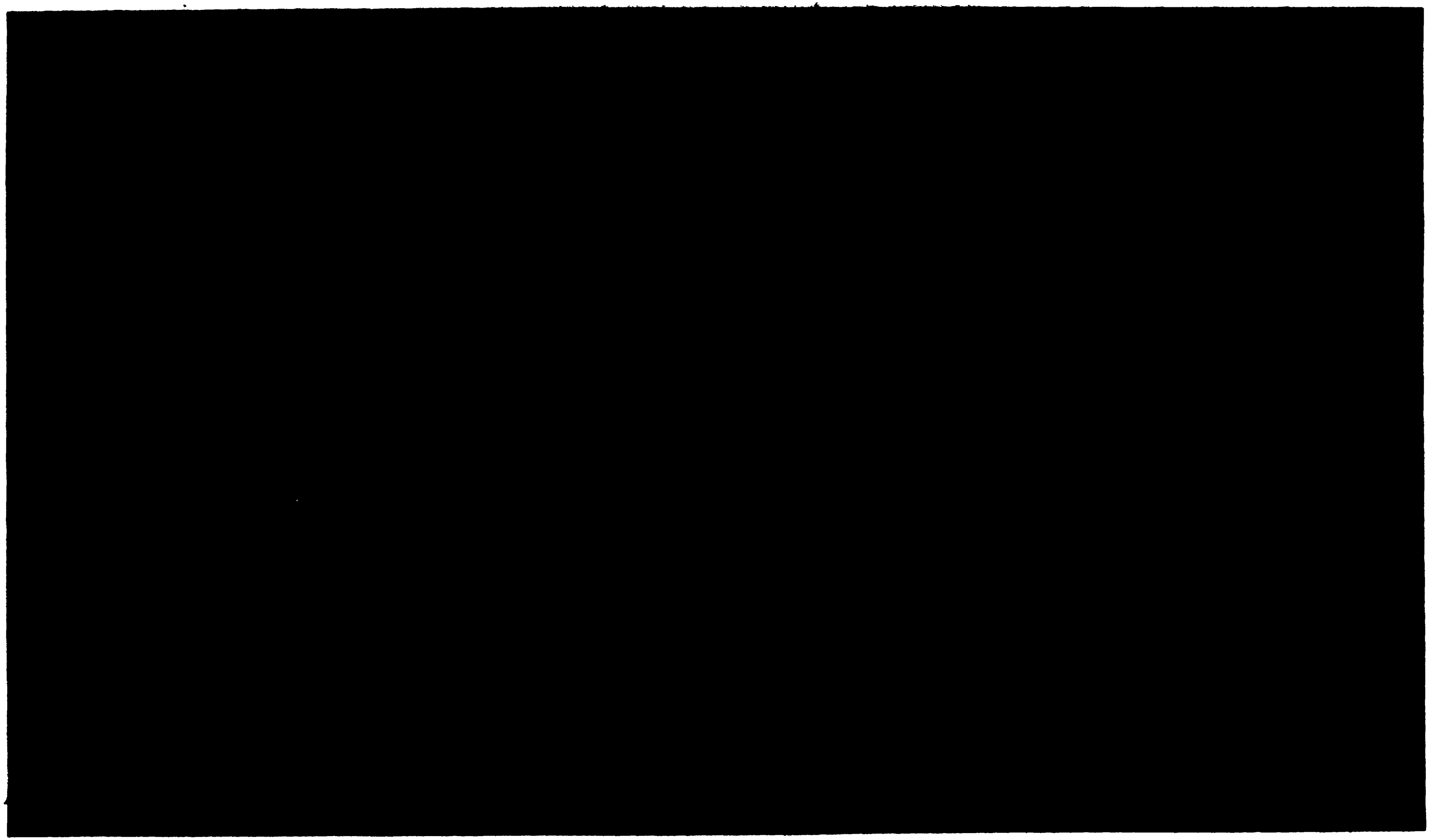
That the reward to the plant breeder who is successful is of a substantial nature is well known. The man who produced a pure white daffodil was able to sell his bulbs at fifty guineas apiece for some years. In the same way the breeder who introduces a really blue rose, if this should ever come about, will, without doubt, make a large amount of money. Of course, whether these floral fancies are really worth the money is a matter of opinion. There is no gainsaying the fact, however, that a great deal of really good work has been accomplished in the way of giving fresh beauties to flowers and uses to plants of all kinds.

We know that the prickly pear cactus will grow in very dry situations. Now the stems of this plant offer very good fodder for cattle, only they are quite impossible because of the dreadful spines with which they are covered. An American breeder has set himself to produce a spineless cactus. This he has been able to do; we seem to be within measurable distance of the time when the deserts of the world will support cattle.

Photo by S. L. Bastin

The Progress of the Sweet Pea

There is no flower which has been more marvellously developed from obscure beginnings than the sweet pea



The New Naval Air Scout Hovering Over a Misty Sea

(Drawn by Christopher Clark)

Ascending from some sea-coast base, the new naval airship will be able to reconnoitre above the water for days on end, reporting constantly to head-quarters by means of wireless telegraphy

Photo Branger, Paris

Photo Taken from an Aeroplane

This clearly shows how, from his bird's-eye point of view, the airman can spy over the enemy's country, himself often invisible

War in the Air

How the Aeroplane and Airship Have Transformed the Science of War on Land and Sea—Britain no Island in the Future—Exit "the Fog of War"

ON the eve of naval warfare it is the aim of a fleet, as of an army, to conceal from an enemy its position and strength; to take your foe unawares, and at the moment which suits you best, is to be on the road to victory.

Hitherto, in scouring the sea to find some lurking foe, fast torpedo-boats and destroyers have been employed; but the conquest of the air brings a new instrument to hand—one which is immensely swift and gives the spy a view over vast stretches of water.

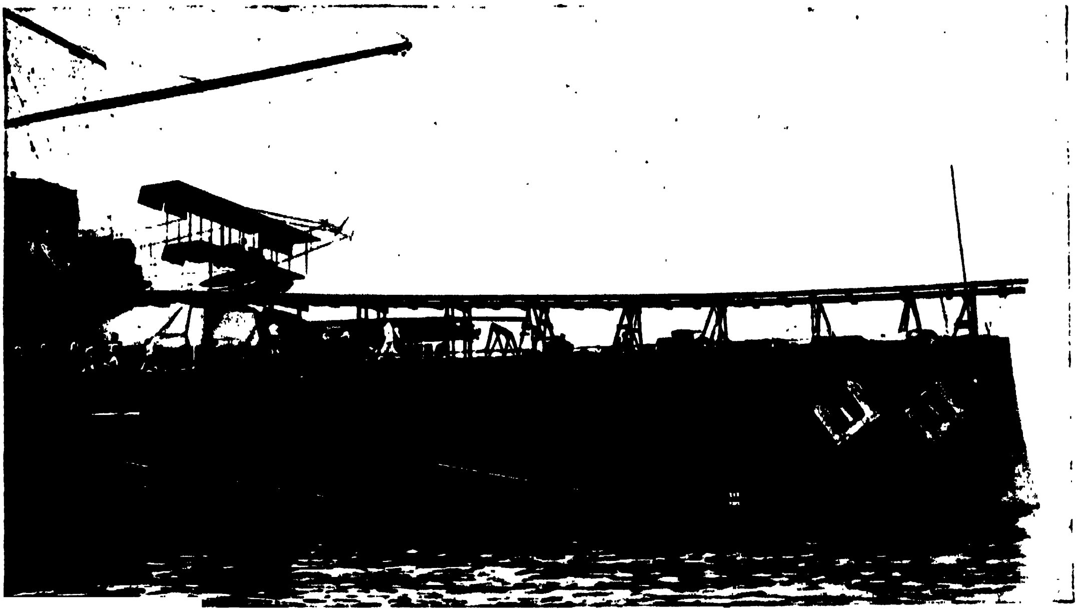
The experience gained by each of the belligerents in the Great War has shown the possibilities of aircraft. Accompanying fleets of the future will be long, low, mastless craft, their spacious decks stripped bare. They will be the parent ships for aeroplanes; and inside their roomy hulls, packed away neatly in sections and waiting to be raised to the deck above, will be aircraft of a special design. These promise—so far as one may judge at the present time—to be small monoplanes, very powerfully engined, and seating a single scout. Capable of high speeds, they will have ability to weather the strong, steady winds so frequently encountered at sea.

Airship Attacked by Aeroplanes while Bombarding a Naval Base

(Drawn by Harold Piffard)

Stationed in harbours and housed in floating sheds, coast defence aeroplanes must be ready to give battle in their own element to such aerial invaders as may dare to approach their shores. It is vitally necessary for Britain's coast to be girdled with an air-patrol

When needed for duty, they will be assembled in the ship's interior, then brought to the deck and launched one by one, rising skyward in all directions, and traversing hundreds of miles of ocean in a few hours' flight. In launching an aeroplane from a ship's deck, no great mechanical difficulties are encountered; it has already been done, even from an ordinary warship, the decks of which are encumbered. Given a specially cleared space, therefore, the manœuvre should be carried out with ease. But the return of the aeroplane to the deck is a more difficult matter, particularly in a high wind or rough sea, and some practicable receiving mechanism remains to be adopted—although M. Bleriot has tested successfully a device by which the descending aeroplane, being fitted with a catch, makes contact with a wire cable and is brought gradually to a halt.


Photo, [illegible]

Launching and Landing Platform on a British Warship

In the future there will be specially designed parent ships for naval aeroplanes, which will be packed away in sections in their roomy hulls. When needed for duty, they will be assembled in the ship's interior, then brought to the deck and launched one by one, rising skyward in all directions, and traversing hundreds of miles of ocean in a few hours' flight

From his bird's-eye point of view, thousands of feet aloft, the naval airman will spy upon an enemy's fleet while he himself—an elusive speck against the sky—remains invisible. Wireless telegraphy will be brought to his aid, to enable him to flash to his flagship a report while still in flight, and the radius will be increased, undoubtedly, as apparatus is improved. Flying at a hundred miles an hour, and reporting instantly all he sees, one air-scout will not only do the work of several torpedo-boats or destroyers, but do it more effectively.

Another service for naval aircraft will lie in coast patrolling and defence. Here, again, a special type of machine is needed. Stationed in harbours, and housed in floating sheds, these sea-planes will be duplicate-engined craft which, rising from the surface of the water, will scout along coastlines, and be ready to give battle, in their own element, to aerial invaders who may approach their shores. The crew of such a patrol will probably consist of a pilot—and perhaps also an engineer—with an observer and a man to handle the machine-gun, which will be mounted forward, clear of the sweep of the planes. These coastal craft—like the high-seas scout—will be in communication with harbour bases by means of wireless. It should, in Britain, be our aim to girdle the coasts with an air-patrol, and Parliament is now awakened to that need.

The Naval Airship

Then there is the naval airship—huge and costly to build, it is true, but capable of remaining in the air for long periods; and it is this quality which must render her so useful in naval war. Ascending, for instance, from a sea-coast base, she will reconnoitre above water for days on end, traversing a pre-determined path, and reporting constantly by wireless. As an example of present possibilities, one need only cite the exploits of the German Zeppelins which crossed the North Sea again and again to raid our coasts during 1915 and 1916. Such tests show the value of a long-range airship when attendant upon a fleet. Flying high, she would see great distances on every hand and, keeping in constant touch with her flagship, would provide a constantly watchful eye for the fleet below.

The destructive potentialities of an airship must be considered too. When armed with bombs and special guns, it will undoubtedly, in the course of a few more years, develop into an instrument highly formidable to fleets and harbours, and in raids over an enemy's country.

The failure of Germany to achieve any great military success by the use of her Zeppelins in 1914 - 15 does not argue that the peril from above can be ignored. The next few years may see astounding developments in lighter - than - air craft in this country, as well as on the Continent.

In the past as two armies neared each other, the Commanders-in-Chief threw out screens of outposts, and, shielded behind these, moved the real strength of their forces. But neither Commander knew how, when, or at what point his opponent would develop a main attack—although such knowledge was of vital interest; so they crept upon each other slowly, definite news of a movement of troops, however trifling, being awaited anxiously.

Each army, it is true, sent out scouts, both on horse and afoot. But mounttains, woods, and unfordable rivers, and skirmishes with the enemy's outposts, prevented them obtaining more than fragmentary tidings; yet a misunderstanding of any one of these reports might entail a wholly false move, and perhaps the loss of an action. Blunders were in truth made, opportunities lost, whole army corps mislaid, and engagements fought with haphazard zeal. Neither Commander-in-Chief knew—so the military saying goes—"what was on the other side of the hill."

Military Aviation

In battles of the future the Commander-in-Chief will anticipate all else by calling a conference with his officer directing air-scouts. To him he will indicate the tracts of country which must be reconnoitred from the air—not only to locate an enemy, but to survey the lie of the land, and note points of strategic value. Arranging the flight of his squadron so that the machines spread out like a fan and cover a maximum area in a minimum time, the officer in charge of aeroplanes will give instant effect to the orders he has received. Rising 3,000 feet or more, with pilot at his levers, and observer with maps and notebook before him, the aircraft can glean, in an hour aloft, news that would take cavalry scouts a day to obtain; and this information, when analysed, will be hastened to the Commander-in-Chief. He, then, will mark upon his maps the positions to which the enemy has moved, or is in the process of moving.

In this way will be eliminated what has

A War Picture of the Future

(Drawn by Henri Lanos)

Suppose two armies, converging for battle, both having air-fleets; what happens when they meet in conflict, thousands of feet above the earth, as inevitably they must do? The imagination pictures such fighting as man has not yet seen

Exit "the Fog of War"

been called "the fog of war." Battlefields will be spread like chessboards. Each commander will see where the enemy is massing his men, where a blow is likely to be struck, and where he himself has opportunity for decisive action. Precision of movement will govern war; clumsy, rule-of-thumb campaigns will be things of the past; and blows, when they are struck, will be swift, scientific, and probably crushing.

Not only as scouts can aeroplanes and airships figure in war, but as instruments of destruction also. As to this aspect of their use, the Great War will provide definite data. This much is known, certainly: bombs may, with effect, be dropped from the air — so actual tests in war have shown — and machine-guns fired accurately from aircraft while in flight. The rest is a matter of organisation and skill.

To be definitely destructive, however, aircraft must be used in numbers. An assault from a few bomb-dropping machines, delivered without system, must be negligible. But large air-squadrons, in which each unit is equipped specially for destructive work, and for that alone, must provide a factor in war that needs to be reckoned with. Lines of communication, supply stores, and fortifications— these are all subject to attack from the air; while troops in camp can be harassed at night, or fired upon from above when toiling on the march.

But suppose two armies, converging for battle, both having air-fleets; here is a problem indeed. What happens when the two fleets meet in conflict, thousands of feet above the earth, as they must inevitably do?

The feeblest imagination pictures such fighting as man has not yet seen. Speed, sheer manœuvring power, a perfectly trained "crew," and a man who is an expert at his gun—such will be factors for success in a duel of the air. Two opposing craft will wheel and swing, before actually engaging, so as to seek position and altitude; and then there will be a dart and a splutter of fire, and one of the two mechanical birds, grievously winged perhaps, will flutter away earthward.

These aerial battles, in the campaigns of the future, will precede engagements on land, and it will be of vital necessity—by the use of squadrons of purely fighting craft—to obtain, and hold, the command of the air. Should he lose this, indeed, a Commander-in-Chief will be like a blindfolded man, groping to fight against one who can see.

Britain no Island

With the coming of aircraft, we should remember that Britain is no longer an island; and so to the protection of our fleet, which should check an enemy approaching from over-sea — we must add an air-patrol, efficient in every detail and adequately armed, which will meet invaders by night or by day, should they descend upon us from the sky.

Fast fighting sea-planes; long-range, high-powered airships; and land guns to throw shells into the air— these are our means of defence against this peril from above.

If They All Grew Up!

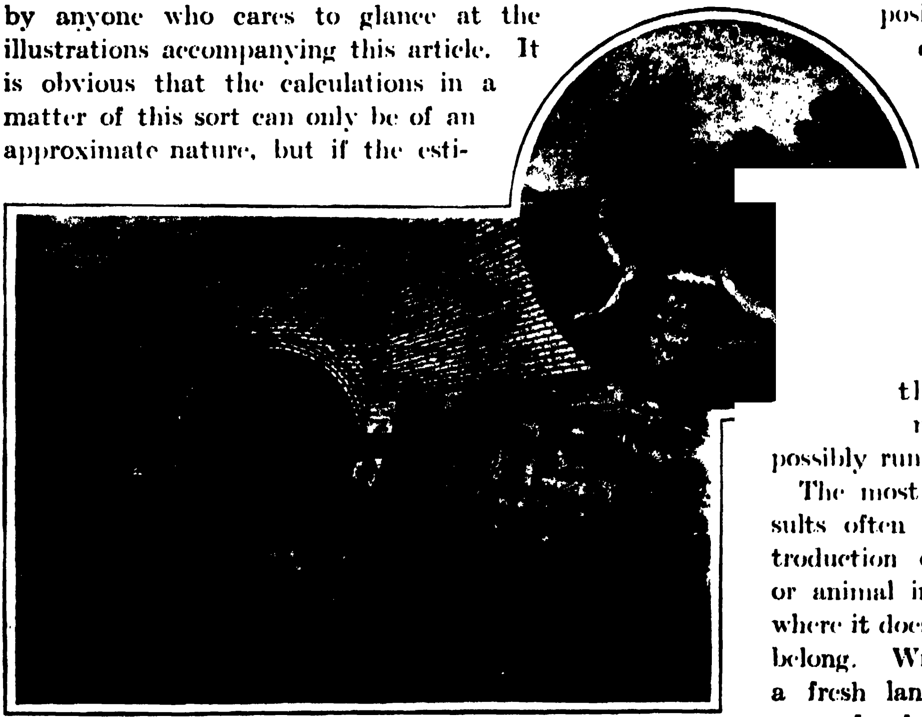
Would there be Room for the Human Race if the Heavy Mortality of Animals and Plants were Suspended?

By S. LEONARD BASTIN

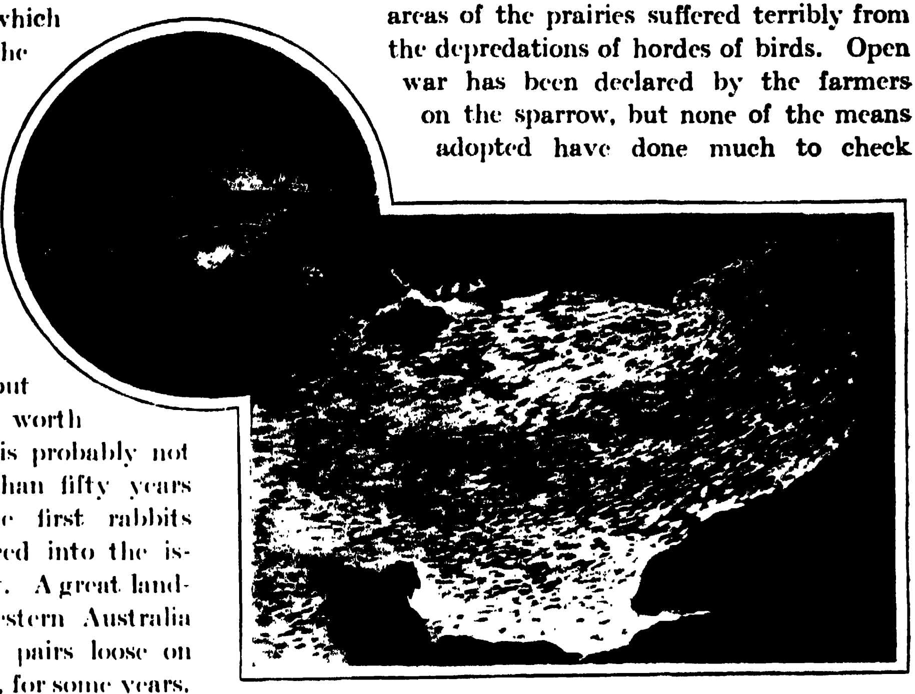
MOST of us realise that the mortality of young animals and baby plants is very considerable. In a very large number of cases this difficulty has been met by an astonishing abundance in the matter of increase. Obviously, each individual has to fight against tremendous odds, and it is interesting to consider the appalling consequences which would arise if the adverse conditions were removed, and the progeny of any plant or animal all grew up. That the conclusions are startling in the extreme must be admitted by anyone who cares to glance at the illustrations accompanying this article. It is obvious that the calculations in a matter of this sort can only be of an approximate nature, but if the estimates err, they do so on the conservative side.

Everybody knows that rabbits are amongst the most prolific of breeders, starting at a very early age, and keeping on producing litters at an astonishing rate. An estimate given by Dr. Richard Lyddeker on the progeny which would result from the breeding of a single pair of rabbits, if these were unchecked for three years, results in the startling figure of 13,718,000. Some idea of this enormous number may be conveyed by supposing that the creatures were loosed in the tubes and underground railways of London. The lines, platforms and stairways would be more than covered, no trains could possibly run.

The most surprising results often follow the introduction of some plant or animal into a country where it does not naturally belong. With removal to a fresh land there may come freedom from peril or restrictions, and the



Within three years the descendants of one pair of rabbits, if they all came to maturity, would fill the tube railways of London plant or animal increases to an alarming extent. Some very remarkable instances of this have occurred, and in not a few cases the new-comer has proved a veritable curse, from which the people of the country have vainly tried to deliver themselves.



If they all came to maturity, the fish from the roe of one parent cod would fill the English Channel

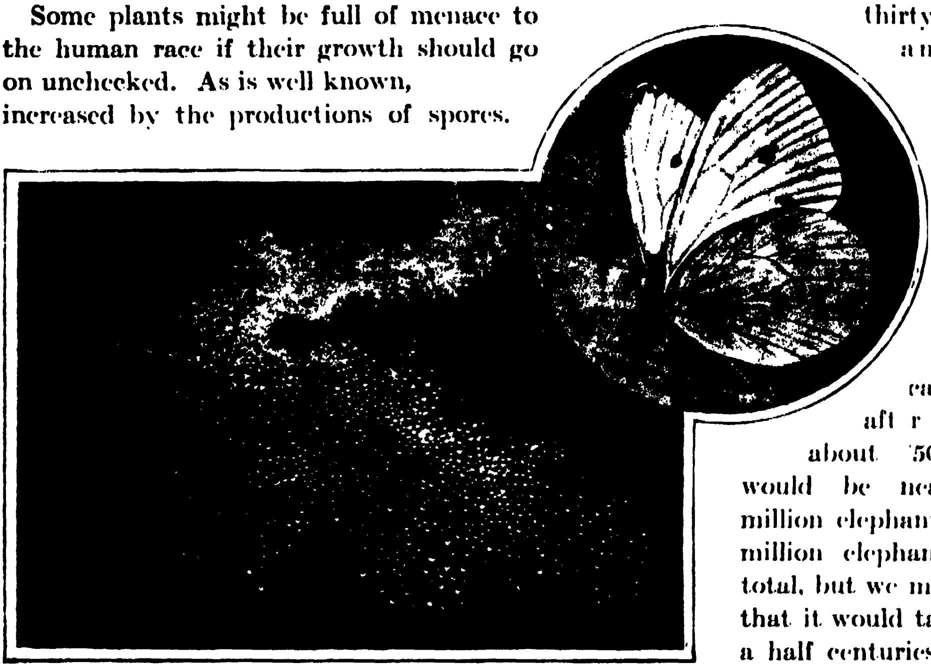
Of course the case of the rabbit in Australia is familiar to most people, but the facts are worth reciting. It is probably not much more than fifty years ago since the first rabbits were introduced into the island continent. A great landowner in Western Australia turned a few pairs loose on his estate and, for some years, a good deal of satisfaction was felt at the way in which the rabbits were establishing themselves. But the joy was short-lived, for it was soon seen that the rabbits were spreading over the country to an alarming extent. The climate suited them admirably, and their natural enemies were very few. Crops of all kinds suffered terribly from the depredations of the creatures, and it was not long before farming was seriously handicapped by the plague of rabbits Special legislation was introduced, and it is likely that, during the last quarter of a century, several million pounds have been spent in an attempt to exterminate the rabbit in Australia. In spite of all this, rabbits are still a great pest in many parts, and seem likely to continue to be so. Very much the same kind of thing has occurred in New Zealand.

In the year 1862 some misguided settler introduced a pair of sparrows into the United States. In the new country the birds multiplied with extraordinary rapidity until, within a short while, the sparrow had become a great pest. The vast grain areas of the prairies suffered terribly from the depredations of hordes of birds. Open war has been declared by the farmers on the sparrow, but none of the means adopted have done much to check the pest. The natural enemies of the birds seem to be very few in America. Both in New Zealand and Australia a very similar state of affairs exists: removed from practically all restraint, the sparrow has become a dreadful pest. In some districts farmers have been brought almost to ruin by the attacks which the little brown birds make on their crops.

Offhand, one would think that there was plenty of room in the sea, no matter how rapidly the number of fishes might increase. This is really very far from being the case. Frank Buckland estimated that the number of eggs which would be present in the roe of a fair-sized cod would not be less than 7,000,000. It is not very easy to realise what this huge number really means, but it is quite certain, supposing all the cod reached maturity and bred once, that the English Channel would be blocked with fish. As a matter of fact, only a small number of cod's eggs ever hatch, seeing that the spawn of the cod is a favourite food of a host of sea creatures. It is said that even the father cods themselves will feast on the egg clusters!

The common white butterfly looks innocent enough as it flutters over the garden on a warm day. Yet in this single insect we should be faced with a terrible problem if all the progeny of one female grew up and bred without hindrance. The calculation is rather a formidable one; still, it is possible to show that, at the end of three years, we should have a respectable total of at least one thousand million white butterflies. Should these visit the London district, the whole of the great City would be cast into the gloom of night.

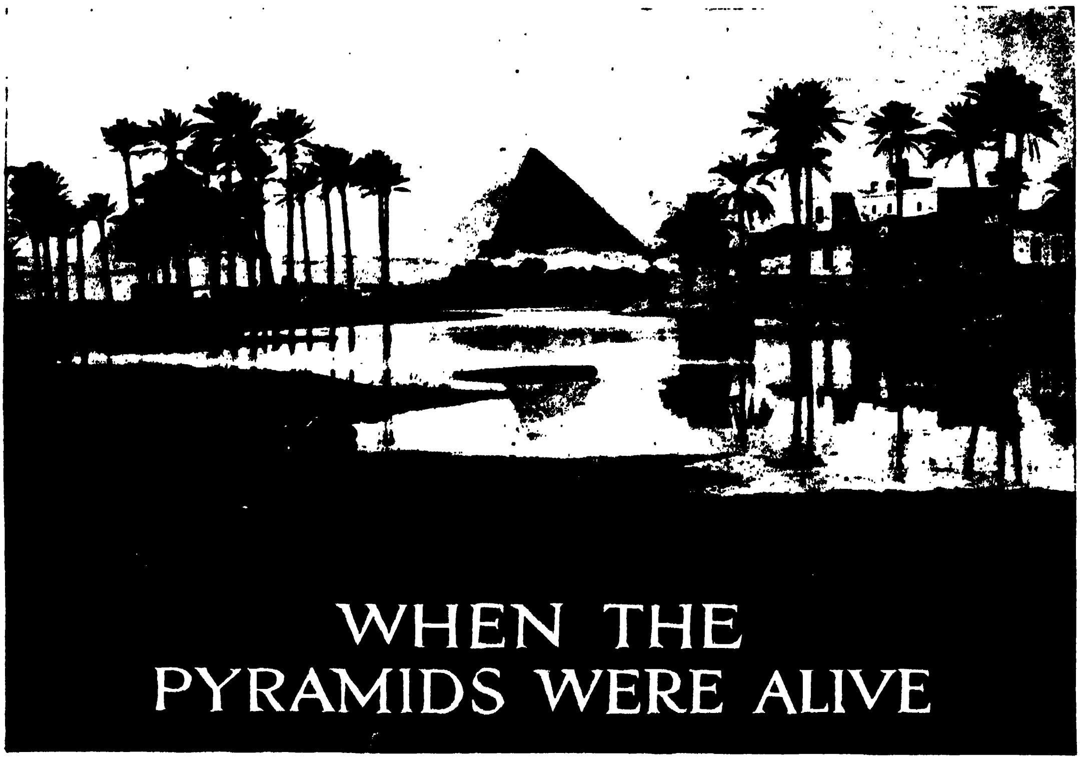
Some plants might be full of menace to the human race if their growth should go on unchecked. As is well known, increased by the productions of spores. These spores are borne in very large numbers, and in the case of the tropical fern known as *Angiopteris*, each frond has been estimated to produce no less than four thousand million spores. Now each one of these will, under suitable conditions, give rise to a new fern plant of considerable size. Thus, the clouds of brown dust would, in favourable circumstances, produce enough plants to cover the whole of Devon and Cornwall.


If all the progeny of one common white butterfly came to maturity and bred, within three years 1,000,000,000 butterflies would darken London

Almost as surprising would be the results of the germination of all the spores which are produced by a solitary mushroom. If these could be evenly distributed in Hyde Park, we should be able to convert that famous piece of ground into a gigantic mushroom bed!

Here and there in the world there are some rather remarkable cases of slow increase. Darwin went to a great deal of trouble to work out the probable rate of increase in the case of elephants. These animals begin to breed when they are thirty years old, and between that ninety a female may be expected to produce six young. It is on these facts that Darwin calculated that after a period of about 750 years there would be nearly nineteen million elephants. Nineteen million elephants is a large total, but we must remember that it would take seven and a half centuries to arrive at this number. The great herd would not take up anything like the amount of room which might be expected. Indeed, making a liberal allowance in the matter of space, we should be able to find plenty of room for the elephants in the Channel Islands.

I.—On the Land : Artificial



WHEN THE PYRAMIDS WERE ALIVE

Photo: Printing Craft, Ltd.

The Great Pyramid of Cheops

The Wonderful Story of the World's Greatest Monuments

By N. F. WATSON

WHEN the Assuan dam (a mile and a quarter in length, ninety feet thick at the base, ninety feet high, and twenty feet thick at the top), one of the mightiest of modern structures, was building, the late Earl Spencer asked the engineer in charge how it compared in magnitude with the Great Pyramid. "It contains," was the answer, "just about a quarter of the material of the Great Pyramid!" The comparison refers only to the existing dimensions of the Pyramid, which, having acted for centuries as a quarry for the mosques and palaces of Cairo, is considerably reduced in bulk. Even so it remains by far the greatest monument in the world.

As it stands to-day, its four sides each measure in greatest length, 775 feet—the pillaging of vandals having reduced the length by 20 feet each side. Its height is now 451 feet; it was formerly 481 feet. It covers 13½ acres of land, more than the whole of Lincoln's Inn Fields; it is many times as large as St. Paul's Cathedral, and 85 feet higher. The Pyramid, after having lost 4,000,000 cubic feet of material, contains to-day no less than 85,000,000 cubic feet of stone, sufficient, if drawn out in a line a foot square, to reach two-thirds of the distance round the earth. And yet this titanic mass once had life!

Its constituent elements had their being, lived and loved, hungered and fed, and reproduced their kind, died and sank in the seas that exist no more, in such unthinkable numbers that their shells and bodies formed rocks thousands of feet deep, mountains thousands of feet high. The pyramids were once alive; the inscrutable

Building a Pyramid

Equipped with a succession of pulleys, with hundreds of men hauling at the ropes, the great masses of masonry were slowly raised skyward and lowered into position, so perfectly that not a pin can be thrust into the divisions. In the largest Pyramid of all there are 7,000,000 tons of masonry, fitted together as exactly as the works of a watch

Sphinx is composed entirely of fossil corpses, compounded in Time's crucible into solid rock, from which the skilled hands of a bygone age carved it as a sentinel looking out across the desert dotted white with dead men's bones.

The living forms, of which great part of the Arabian range, in common with a considerable element of the Apennines, the Alps, the Carpathians and the Balkans, is composed, were merely nummulites, or nummulina, a genus of fossil foraminifera. They lived and multiplied in teeming hosts, outnumbering the stars. They were circular-shelled animals, varying in size from the microscopic to swaggering giants as big as half-crowns. And as innumerable hosts of living forms of life died to make the white walls of old England, so these nummulites died for their shells to agglomerate, age after age, and become converted by Nature's inimitable metamorphosis into solid rock.

Long ages ago some forms of life were distinguished by the colossal dimensions to which individuals attained; others by the incredible fecundity of the species. The giants perished, as all abnormalities must, and the teeming nummulites to-day are represented by few species.

Deposit of nummulites followed deposit, the fleshy parts dissolved, the interiors became solid with the mineral properties from sea-water, of which the shells had first been built up; the shells of still tinier foraminifera filled in the gaps between nummulite and nummulite. Thus, as layer upon layer of corpses rose, the sea received a new bed, which, as the waters rolled back, formed stony rocks for the conies, high hills as refuge for the wild goats, all as the Psalmist sings.

To say that these fossil forms are countless as the sands of the desert is hardly correct, for they themselves are the sands of much of the desert. Such sands are one in origin with the stones of the pyramids. The sands are not always the detritus left by a vanished sea. They are the comminuted fragments of the rocks of other days. Wind, and rain, and change of temperature, and all the incidents which in course of time bring the mountains powdering to the plains, have helped to make sand of the rocks that once were living animals.

Photo: Underwood & Underwood

The Great Quarry at Masara

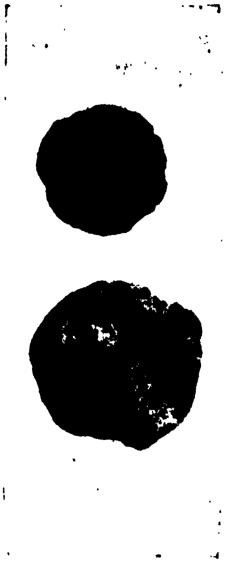
From this ancient quarry were delved the mammoth monoliths from which the pyramids were built

The pyramids themselves have contributed to the debris of the desert. Many of the shells exactly resemble lentils in their form and size, and this fact gave rise to a curious misconception. Time, wearing down the huge monuments, brought enormous numbers of the fossil shells to the base, so that they impede the foot of the traveller. For long it was believed that these were the remains of seeds, used as food by the ancient workmen of the pyramids, and that by the action of time the seeds had become fossils. Of course, they were simply nummulites dislodged from their matrix.

Now, except for certain slabs of granite brought from Assuan at the first cataract, the whole of the stone for the pyramids was quarried from the range of hills on the right or east bank of the Nile. And those rocks are entirely composed of what were once living animals, the nummulites of days long before the dawn of man. So it is true to say that the pyramids and Sphinx were once alive.

How came these pyramids to take shape and form? How did these vastest of all human monuments arise in the land of old Nile, and for what purpose? We may confine ourselves to the Great Pyramid, the supreme wonder of all. This grandiose structure was the creation of Cheops, King of Egypt, nearly 6,000 years ago. It was the custom of an Egyptian king of this era, immediately he mounted the throne, to set about building his tomb. Bismarck in his later days used to say: "I live now for an epitaph"; the early kings of Egypt lived to witness the completion of their tombs. The pyramid habit did not begin with Cheops; it culminated in his gigantic structure.

We need not gauge the splendour of Cheops' imagination by the size of his pyramid, for Dr. Souttar holds that the monarch, having no standard to measure by, had little conception of what he was undertaking when he began it, and, having once begun, was ashamed to leave it unfinished. The custom of building pyramids was continued for centuries, but no successor of Cheops attempted to rival the earlier work, and the size and splendour of pyramids dwindled, until at last the practice of erecting them vanished entirely. If Dr. Souttar's theory be well founded, and there is no reason to doubt it, the feat of constructing the Pyramid remains none the less amazing. For here we have an incomparable miracle of building, carried out with perfect accuracy and symmetry, by a man who, beginning what seemed a simple task, found himself committed to an enterprise never before or since approached in magnitude.


Nummulites

Sectional and external views, both much magnified

The great tomb-pyramid is situated on a rocky plateau some 100 feet in height, about seven miles from old Cairo, at the edge of the desert, and overlooking the valley of the Nile. It is built up in tiers or terraces, 206 in number, the tiers ranging between 26 inches and 58 inches in height. The sides of the Pyramid during building were, therefore, like a long flight of steps, and these were eventually filled in with right-angled triangular stones, so that the surfaces were left smooth—not serrated as they now appear. The stones in the Pyramid vary in weight from two tons to 60 tons. The outer casing has been almost entirely stripped off, but from the sections remaining in place we get an idea of the nature of the masonry employed, the casing-stones intact weighing about 16 tons each.

Within the Pyramid are several chambers, galleries and shafts, of which latter, one admits air. The first chamber for the dead was excavated in the solid rock of the plateau, and the Pyramid built round it. This plan was altered during the building, and the substantive chamber constructed

Photo. American Colony, Jerusalem

Ascending the Great Pyramid of Cheops

in the masonry of the Pyramid. The first is 17 feet in one direction, 19 feet in another, and 20 feet in height. This, it is supposed, was intended for the king, but his reign lasting long, and the work remaining incomplete, the chamber was dedicated to the remains of his queen. A passage, 820 feet in length, led to the original chamber in the rock. A second gallery was constructed to the queen's chamber, and this, continued a further 150 feet, leads to the heart of the Pyramid, where the resting-place of the king was at last prepared. Here a chamber 34 feet by 17 feet, and 19 feet in height, was fashioned.

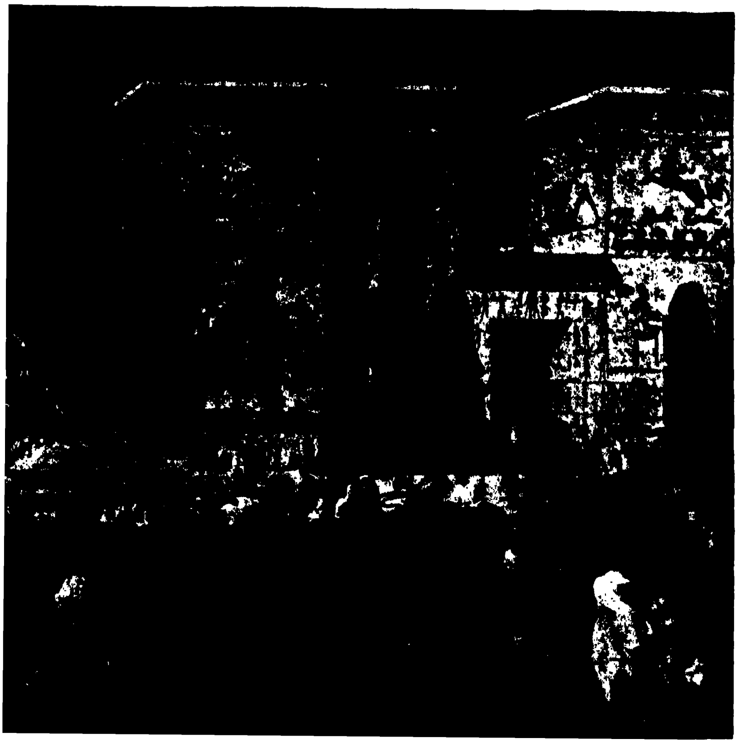
In order to complete the Pyramid it followed that an enormous mass of masonry must be raised above the roof of the king's chamber, and to lessen this weight a flight of five chambers, one above the other, was constructed over the king's chamber. The latter is roofed with slabs of polished granite, nine of them, each 18½ feet in length, fitting so perfectly together that, as a high authority has said, it is impossible even to-day, after 6,000 years, to insert the point of a pin between the joints! On the roof of the topmost apartment, placed above that of the king's chamber, is one of the only two memorials of the builder. It is a name scrawled in red—Cheops—placed there, it is supposed, by one of the toilers who helped to raise the structure 6,000 years ago. The second memorial lies, appropriately, in the death chamber. It is a broken red granite sarcophagus, 7½ feet long, 89 inches broad, and 41 inches high. And in that, sixty centuries ago, they laid the enswathed mummy of the tyrant who enslaved a whole nation to raise this cloud-piercing mausoleum.

What manner of man was Cheops, for whom the greatest tomb in the world must be prepared? We know less of him than of many kings laid in humbler graves. The great passion of his life was the building of the tomb in which he hoped to spend eternity. He closed all the temples of Egypt, we are told, forbade all sacrifices and worship, to the intent that he might have the services of the entire nation concentrated upon the task of his life. With all his resources he found the expense beyond his means, and sold the honour of his royal house to raise money.

The manner of building is one of the secrets buried in the mighty past of Egypt. The only dependable account left to us is that of Herodotus, who, nearly thirty centuries after the event, heard the story from the priests of Heliopolis, the home

"Israel in Egypt" Portrays the

It is not generally realised that the Egyptian people ther



'eople's Sufferings in Pharaoh's Service
elves were also enslaved to build the Pyramid of Cheops

of Cleopatra's Needle. Here, in Cary's translation, is the historian's brief narrative of the tremendous operations:

"He ordered all the Egyptians to work for himself. Some, accordingly, were appointed to draw stones from the quarries in the Arabian mountain down to the Nile; others he ordered to receive the stones when transported in vessels across the river, and to drag them to the mountain called the Libyan. And they worked to the number of 100,000 men at a time, each party during three months. The time during which the people were thus harassed by toil lasted ten years on the road, which they constructed, along which they drew the stones, a work, in my opinion, not much less than the Pyramid; for its length is 5 staves (3,051 feet), and its width 10 orgyæ (60 feet), and its height, where it is the highest, 8 orgyæ (48 feet); and it is of polished stone, with figures carved on it. On this road these ten years were expended, and in forming the subterraneous apartments on the hill, on which the Pyramid stands, which he had made as a burial vault for himself, in an island formed by draining a canal from the Nile Twenty years were spent in erecting the Pyramid itself. Of this, which is square, each face is 8 plethra (820 feet), and the height is the same; it is composed of polished stones, and jointed with the greatest exactness; none of the stones are less than 30 feet.

"This Pyramid was built thus: In the form of steps, which some call crossæ, others bomides. When they had first built it in this manner, they raised the remaining stones by machines made of short pieces of wood; having lifted them from the ground to the first range of steps, when the stone arrived there, it was put on another machine that stood ready on the first range, and from this it was drawn to the second range on another machine, for the machines were equal in number to the ranges of steps; or they removed the machine, which was only one, and portable, to each range in succession, whenever they wished to raise the stone higher, for I should relate it in both ways, as it is related. The highest parts of it, therefore, were first finished, and afterwards they completed the parts next following, but last of all they finished the parts on the ground and that were lowest.

"On the Pyramid is an inscription in Egyptian characters, showing how much was expended in radishes, onions, and garlic for the workmen; which the interpreter, as I well remember, reading the inscription, told me amounted to 1,600 talents of silver (£200,000). And if this be really the case, how much more was probably expended in iron tools, in bread, and in clothes for the labourers, since they occupied in building the works the time which I mentioned, and no short time besides, as I think, in cutting the stones, and in forming the subterraneous excavations."

Upon that foundation an edifice of speculation, vast as the Pyramid itself, has been erected. Many books have been written on the building of the mausoleum. One school has it that the method of getting the blocks to the Pyramid and into position must have been entirely by way of an inclined plane from the bank of the Nile, and rising as the Pyramid grew in height. But, apart from the testimony of Herodotus as to the machinery employed, we have it that the gradient of an inclined plane reaching to the summit of the Pyramid would have been quite impossible.

Building the Mausoleum

According to Herodotus, 100,000 men were at work for twenty years. It has been shown that this represented the equivalent of 20,000 horse-power, which, in the time occupied by the actual building of the Pyramid — ten years, if we eliminate the nights when labour was stilled—would suffice to drive a 10,000-ton steamer seventy times round the world at twenty knots an hour. Supposing that it were possible to move the entire Pyramid, over 100,000,000 stalwart men would be required to pull it.

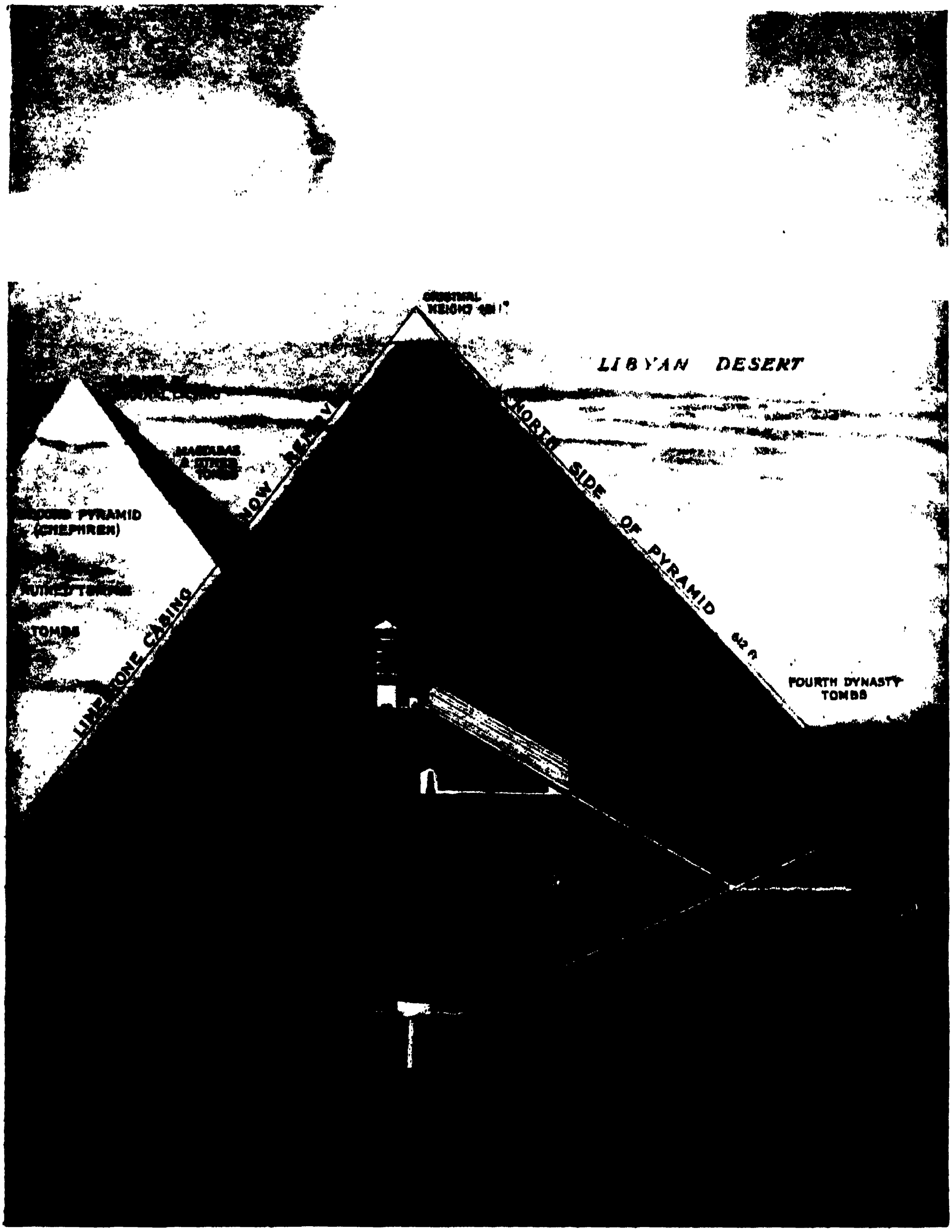
But with all the labour that Cheops had available, the mystery of the hauling of the mighty stones, many of them sixty tons in weight, high up the Pyramid, remains to be explained. How were they obtained, hauled, placed in position? We regard the Egyptians as using flint implements. But, long before the first dynasty of kings, they made admirable tools of copper and bronze, and it was after intercourse with these early Egyptians that there trickled into Europe the first men to use metal in the Stone Age of the West.

In the spring of 1911, Mr. G. A. Wainwright found in pre-dynastic graves, forty miles south of Cairo, beads of wrought iron, which had been placed there thousands of years before the first line of Egyptian kings arose. If they knew the use of iron, they would employ the metal in their tools. Until 1911, it had been assumed that the Egyptians cut and sawed their stonework with bronze saws set with either diamonds or corundum. We know that they used drills, of which the modern diamond drill for rock-boring is only a re-invention — but now it seems possible that they may have had implements of iron, derived from native sources. This confirms the old belief of Professor Ridgeway, that iron and its uses were first discovered in Africa, or Asia, long before it was known in Europe.

The stones were cut and shaped at the quarries; they were conveyed on rollers to the Nile and ferried over, then drawn along the famous raised roadway upon vast wooden sledges or cradles, the track being greased to lessen friction, in the manner shown us in old tomb-paintings. Here in modern England to-day we find sledges in use for traffic where wheeled vehicles are impossible. All the merchandise that enters Clovelly from the landward side is dragged down the steep-stepped main street upon wooden sledges.

The stones of the Pyramid were manhauled, and the labourers, working like cattle under the lash, would, it has been computed, draw the 60-ton blocks in relays of 900 men at a time. Harnessed in double rank on four ropes, they would cover a space on the causeway of 225 feet long by 16 feet wide. The biggest stone would be about 27 feet by 6 feet, and 4½ feet in height. Hence there was ample space along the inclined plane. Arrived at the

Under the Lash



Sectional View of the Great Pyramid of Cheops or Khufo

(Drawn by G. Torrance Stephenson from Mr. Dow Covington's Plans)

The plans of the great American Egyptologist clearly exhibit the known passages within the 7,000,000-ton monument, which for 6,000 years has stood to commemorate Cheops

site of the Pyramid, the stones were taken in hand by the men with the machines. These have been elaborately considered and described. They were in the main pulleys and cranes for the lifting, and levers and wedges for the fixing in position.

It is believed that each course of stones became the foundation for the superior course. Colonel Howard Wyse, who made a systematic investigation, wrote: "In blocks of each course, where visible, are holes 8 inches in diameter and 4 inches deep, apparently to support the machinery described by Herodotus. In front of the northern face of Cheops are several rows, 4 or 5 feet apart, of three or four circular holes in the level rock, about 12 inches in diameter, and 8 to 10 inches deep, to support shears or scaffolding for turning the blocks."

Thus, equipped with a succession of pulleys and with probably master cranes on the lowest tier, with hundreds of men hauling at the ropes, the great masses of masonry would be slowly raised skyward and lowered into position.

And there, after 6,000 years, the Pyramid stands to-day, 7,000,000 tons of colossal masonry, fitted together with the exactitude which characterises the labour of the watchmaker. Covering an area of 18¼ acres, the perfection of the work is such that the four sides of the base have only a mean error of six-tenths of an inch in length, and still less in angle from an ideal square. And all to enshrine the dust of a dishonoured tyrant, which dust has for thousands of years been one with the sand of the desert. For the inviolable sanctuary, that was to be, was not inviolable. Many alien foes have explored its mile of secret ways, and penetrated to the chamber that Cheops fashioned for his eternal sanctuary. But the romance of it all is, with the edifice, imperishable, inimitable, the first of the Seven Wonders of the World. Yet the nummulites began the work with their own substance!

Monuments Which Once Had Life

Except for certain slabs of granite brought from Assuan, the whole of the stone for the pyramids was entirely composed of what were once living animals, the nummulites of days long before the dawn of man

The Railway Station on the Third Level Underground

An Underground City of Salt

The Amazing Story of the Salt Mines of Wieliczka, where Men have Toiled for 1,000 Years

By JOHN PREVOST

IT is fortunate for man, perhaps, that the only mineral that figures in his ordinary diet, namely, salt, is very widely distributed, being found in all parts of the world. From the mines of Cheshire, which have been known and worked since Roman times, many millions of tons must have been obtained. Famous as these mines are, however, they are mere pygmies compared to the mines of Rumania and Galicia.

There are four in the first-named country, that at Slanicu being perhaps the best-known and declared to be the largest in the world. It has an annual output of 78,400 tons, and though it has been worked for nearly a thousand years it is computed that if the annual output were increased to 100,000 tons the mine would not be exhausted for 200 years. This mine belongs to the government, and is largely worked by convict labour.

The most wonderful salt mines in the world, however, are those of Galicia, in Polish Austria. In this region there is a mass of salt which is estimated to measure 500 miles in length, 20 miles in breadth, and 1,200 feet in thickness! Wieliczka is the chief point of attack on this prodigious bulk. For upwards of a thousand years men have been hacking at the salt, and their labours have left a veritable underground city, which is one of the "show places" of Europe. Here, in the bowels of the earth, hundreds of feet below the surface, are roads, houses, churches, chapels, shrines, restaurants, and monuments all hewn out of the rock salt, a record of the art and industry of bygone generations.

So many visitors are attracted to this underground city that the authorities have installed a hydraulic lift, and a regular service of guides. On first descending, one enters the Letow ball-room. This extraordinary chamber, with its glistening walls, its solid mural decorations, illuminated galleries, stalwart pillars, carved like everything else here from the virgin salt, and brilliantly lighted by chandeliers, has a history dating back a century and a half. Since the year 1750, when it was opened, it has witnessed many remarkable gatherings, on the occasion of Royal visits and the entertainment of other distinguished guests. Such receptions are of sufficiently frequent occurrence to make special provision for them worth while. At one end of the chamber the wall is adorned with a colossal Austrian eagle; at the other end stands glistening a thrpne carved, of course, from salt, the crystals of which flash like jewels of ruby-red. Nor is this throne merely ornamental, for the Austrian Emperor occupies it when he comes to the mines.

Salt Miners at Work

The 67 miles of galleries are occupied by over 1,000 miners, who produce 65,000 tons of salt every year. There are 25 miles of railways

This ball-room, which lies at a distance

A Passage Through the Solid Salt

The most wonderful salt mines in the world are those of Galicia, in Polish Austria. In this region there is a mass of salt estimated to measure 500 miles in length, 20 miles in breadth, and 1 200 feet in thickness of 216 feet below the surface, is merely the first of seven storeys in the mine. Only the three upper storeys, which have long since been "worked out," are open to visitors.

From the scene of gaiety and splendour it is but a step to the home of quietude and prayer. Here, off one of the main passages, is St. Anthony's Chapel, the resort of thousands of the devout since it was hewn in 1698. A detailed description of this most interesting fane must be reserved for a later article dealing with the subject of underground places of worship.

St. Anthony's Chapel

On State occasions, or whenever a rich American will pay the cost, the reception halls, chapels and streets of this underground city are brilliantly lit up.

The illumination of the mine is carried out by the authorities according to a regular tariff, the basis of which is the number of persons who may on certain days wish to visit the mine. A first-class illumination, which comprises the lighting-up of the thousand and one candles and electric lamps scattered in all parts of the mines, costs 110 kronen (about £4 10s.) for any number of people up to twenty. For thirty to forty people the charge is 130 kronen (about £5 10s.). For this comparatively small sum the blackness of the mine is transformed from the mere working place of human moles into an enchanted fairyland, with walls of jewels and silver. The effect is immensely heightened by fireworks.

The descent from the first to the second storey of the Wieliczka mine is made by a long series of steps cut in the solid salt before the days of mechanical haulage. At the foot of this remarkable staircase the sightseer is fascinated by a beautiful sight. The giant chamber, "Michalowice," lies before him, a vast and fearsome vault whence the last load of salt was taken, after forty years of daily labour, in 1761. It measures 59 feet long, 92 feet broad, and 118 feet high, the roof being supported by a wooden framework to avoid disaster. In the interior, a salt chandelier, carrying 300 lights, lightens the natural gloom.

Descending by another flight of steps, the visitor enters some smaller chambers, each carved out during the ordinary course of salt quarrying and afterwards dedicated to someone of high position. A turn in the passage brings one to a little bridge, in front of which loom up two massive pyramids of salt, silent guardians of this lonely spot. These monuments to the memory of Franz I. and Carolina, Emperor and Empress of Austria, date from 1812. On the third floor of the mine are the railway station and restaurant, by no means the least features of the underworld.

Of the many marvels of this underground city perhaps the most remarkable is the subterranean lake, lying 700 feet below the surface of the earth. The waters of the lake are dark, thick, and heavy, and over their deathlike stillness a ponderous silence broods. This silence is sometimes broken with startling effect upon the nerves of visitors, for whose benefit a substantial boat plies upon the ghostly lake. It is guided through the Stephanie and Rudolf grottoes by ropes running on pulleys along the sides of the boat, and propelled by a boatman, who, with his hands resting on the stern of the curious craft, pushes it with his feet braced against the rope. The trip across and back takes fifteen to twenty minutes, as the boat moves slowly through the sluggish brine. When a gun, shot off in the middle of the lake, wakens a thousand echoes, and the challenging voice of the boatman evokes loud responses from each corner of the walls and roof, it seems like pandemonium broke loose, or the voices of the imprisoned giants of the underworld indignantly warning off trespassers.

A Subterranean Lake

There are sixteen of these lakes in different parts of the mine, but this is the only one open to visitors. The lower storeys of the mine are sacred to the 1,000 workers.

From a Painting by Sir H. H. Johnston

The Elephant Seal

There are said to be two species of Elephant Seal of the genus *Macrorhinus* or *Mirounga*. One—the subject of this plate—is found on the Californian coast, more especially along the peninsula and islands of Lower California. The other inhabits the coasts and islands of the Antarctic Zone, north of the ice belt. But there is scarcely any difference between the two kinds

Photo sent to Sir H. H. Johnston by the New York Zoological Society

Female and Young Male Elephant Seals

Giants Among Mammals—II

Whale, Elephant Seals, and Walrus

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

THE whales, of course, easily take the first place amongst mammals in regard to development of size. We have no records of any extinct mammal that could vie in this respect with the largest forms amongst the cetaceans; and although large whales once existed on the English and Dutch shores of the North Sea, no extinct whale of ancient times rivalled in size the living rorquals, or even the sperm whale. Indeed, it is doubtful if any vertebrate animal has attained to the same length and bulk as the biggest of the whales, even among the extinct saurians. From the most recent accounts given of the common rorqual or finner whale, and of Sibbald's whale, it would seem as though specimens of both these forms of rorqual might reach eighty feet in length, while in the case of the Blue or Sibbald's whale (*Balænoptera sibbaldii*) the length of 102 feet was recorded on the coast of Iceland in 1896, 92 feet off Newfoundland in 1903.

These mammals, however, are not so impressive to the imagination as they might be if they could be seen on land, or in the shallow waters of frequented rivers. It is a comparatively rare thing in modern times for whales of large size to be washed up on well-populated coasts, so that, in a general way, whales are overlooked in our estimate of the world's wonders.

The whales are now known to have developed in the course of several millions

Photo: W. S. Berridge, F.Z.S.

A Stranded Rorqual

The whales are now known to have developed in the course of several millions of years from the creodont group—land carnivores of a primitive type of dentition, which in size ranged from the bulk of a bear to that of a dog, but with longer heads of years from the creodont group of land carnivores, through some such forms as *Protocuglodon atrox*, recently discovered in the Eocene formation of Lower Egypt. In the same way a later-evolved, fish-eating carnivore (related to the stock which attained other specialised developments, as dogs and cats, bears, hyenas, and otters), also took to the water and became the parent form of the sea-lions, the walruses, and seals.

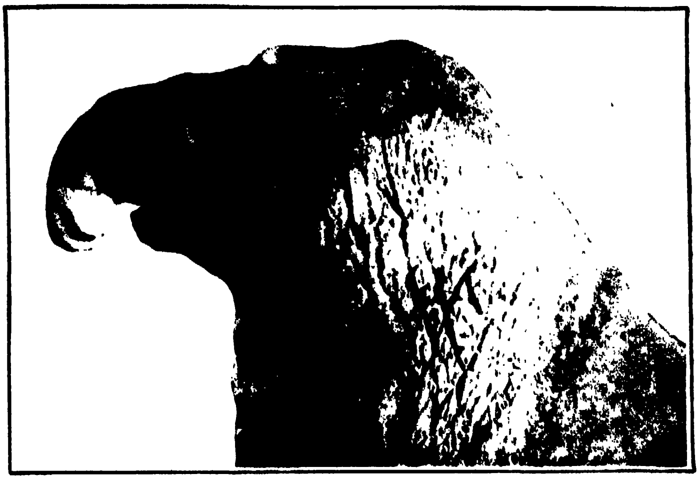


Photo: W. S. Berridge, F.Z.S.

The Elephant Seal

From a stuffed specimen, showing adult growth of mouth

Some such creature as this existed in early Tertiary times in North America, and has been given the name of *Patriofelis*. The sea-lions early branched off from this stock, and although they retained some primitive features and used their hind limbs more like those of the average land mammal, they nevertheless acquired peculiar developments in their anatomy which mark them off from the true seals. The walruses resemble the sea-lions in some points, and the true seals in others, but in their evolution have not only attained very great size—the largest walruses measure 15 feet in length and weigh over 5,000 lb.—but have had their molar teeth reduced to mere grinding "stools," while in the male the canines of the upper jaw have grown into tusks of very great size, which protrude perhaps as much as two feet and a half from the gum in the North Pacific type of walrus.

The seals grew by degrees into fairly large mammals in the northern hemisphere, the biggest type being the Bearded seal (*Erignathus barbatus*), the males of which species measure as much as 12 feet long. This is now nearly extinct in British waters, but down to a few years ago the Grey seal (*Halichœrus*)—often 8 feet in length—was a common and most interesting object off the coasts of Ireland, Scotland, and western England. But it is in the Pacific and Antarctic regions of the world that seals have attained their greatest development in size. There is the very big Weddell's seal of the Antarctic Continent

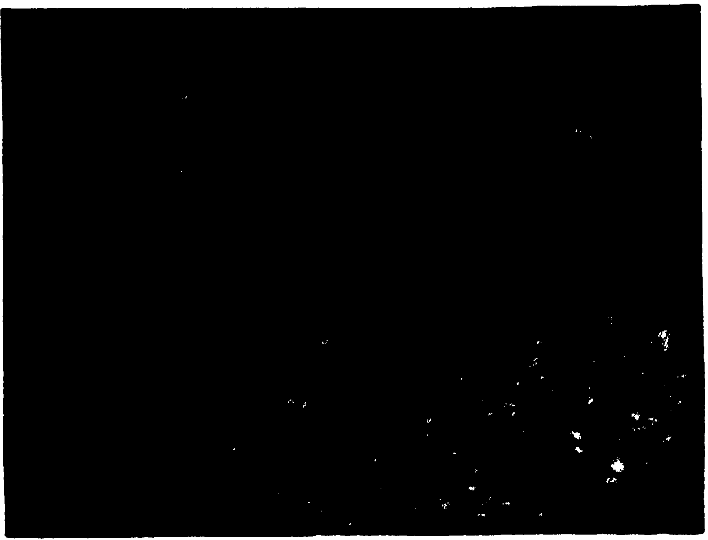


Photo: W. S. Berridge, F.Z.S.

The Grey Seal

The biggest type of seal ordinarily met with in British waters

Photo taken by Sir H. H. Johnston from a specimen in Carl Hagenbeck's Zoological Gardens

The Walrus

The largest male walrus weighs about 5,000 lb. In general it equals in bulk a big cart-horse. In the male the canine teeth of the upper jaw have developed into tusks of very great size, which project perhaps as much as 2 feet or even 2 feet 3 inches from the jaw which has a disproportionately small head, however, and therefore does not look so imposing as the beast I am about to describe. This is the Sea-elephant (*Macrorhinus* or *Mirounga*) of the Pacific coasts of North and South America, but in its largest species of the Antarctic zone. The Sea-elephant, or Elephant seal, is the largest of all this sub-order of aquatic carnivores, for not even the walrus attains to quite the same bulk as a big male sea-elephant, which may be as much as 20 to 21 feet in length. There is almost the same disproportion in size between the males and females in this species as there is between the males and females of the very dissimilar sea-lions. The female sea-elephant—scarcely more than 10 to 11 feet long, looks like a large, round-headed seal; but the male is a very impressive monster, with his inflated and pendulous snout—almost a proboscis—his immense chest, and large canine teeth, with which he can give very severe bites. Unfortunately, for their continued existence, the southern sea-elephants secrete a large quantity (sometimes as much as 200 gallons) of oil in their stomachs, and of oily fat or blubber between the skin and flesh, a padding to enable them to stand the cold of the Antarctic zone. And for this reason they have been during the last twenty-five years, mercilessly hunted by whalers from Norway and North America. The picture with which I am enabled to illustrate the elephant seal is based on an interesting series of photographs taken on behalf of the New York Zoological Society, and shows male elephant seals stranded, killed, or at bay on the beach of islands off the peninsula of Lower California. The species depicted is of course the northern form—*Macrorhinus angustirostris*—of southern California, once also existing along the Pacific coast of Central America down to Panama.

[illegible] the New York Zoological Society

Californian Elephant Seals

The pug-nosed form is the young male, whose nose in the course of five or six years will grow into a veritable proboscis, something like the inflated bladder-nose of the hooded seal

But this species seems to differ in little else than absence of blubber from the *Macrorhinus leoninus* of Antarctic seas. Probably this giant seal at one time had a continuous distribution from the Arctic Ocean (where it may have developed from a hooded seal ancestor) to the Antarctic, by way of the Pacific coast of America.

FLOATING DOCKS

By H. J. Shepstone

Photo S. Cribb

H.M.S. "Monarch," a 22,500-ton Super-Dreadnought,

Steaming into the submerged floating dock at Portsmouth, which after 10 hours lifted her high and dry

The Story of a Great Engineering Achievement

HOWEVER accurately planned and carefully finished a vessel may be, the time comes when she has to go on to the "sick list." The ailment may only amount to the need of a fresh coating or two of paint; or it may be desirable to remove the accumulation of barnacles and marine weeds from the ship's bottom, which have perceptibly reduced her speed. Or perhaps a storm has handled her roughly and a plate has started far below her water-line; or she has run foul of a rock and crashed in a part of her steel walls; and last, but not least, shot and shell may have worked their wicked will upon her.

These repairs can only be effected by placing the ship in a dry dock, of which there are three distinct types—the excavated masonry-lined graving dock, the slipway, and the floating dock. The first two are fixed structures, whilst the last-named can be moved from place to place as occasion demands. They are undoubtedly the most interesting of all docks—huge floating cradles of steel, possessing a mass of delicate and wonderful machinery, and capable of picking up out of the water the largest liner and the heaviest battleship.

At first built of wood, they were very primitive in character. What is declared to be the father of these structures was the quaint, wooden, barge-shaped edifice invented by one C. Watson, of which type a print is still extant, showing such a dock lifting the brig *Mercury* at Rotherhithe, just over a hundred years ago. Still, it was not until the end of the nineteenth century that the advantages of the floating dock became generally recognised. Indeed, so late as the year 1897 there were only 148 floating docks in existence, whereas to-day there are over 400, with, it is estimated, a total lifting capacity of half a million tons. Half the dry docks to be found in the United States, and also in Germany and Holland, are of the floating type.

The most powerful we have in this country is that built by Messrs. Swan, Hunter, and Wigham Richardson, of Wallsend-on-Tyne, for the British Admiralty, and now stationed in the Medway. It has a lifting capacity of 33,000 tons. It is at the Vulcan shipyards, in Germany, that we find the most powerful of these craft, the floating dock there having a lifting capacity of no less than 46,000 tons. We get an idea of her immense strength when it is stated that she raised the *Imperator* clean out of the water, the largest and heaviest of liners. This vessel has a length of 920 feet, a breadth of 98 feet, a height of 96 feet, and a displacement of over 50,000 tons.

Photo supplied by Messrs. Swan, Hunter & Richardson Ltd

H.M. Medway Floating Dock

View of deck from side wall of the 33,000-ton floating dock, showing the lines of keel blocks

The comparatively recent sudden rise in popularity of floating docks is due to the rapidity with which they can be built, their small cost compared with a graving dock, and their wonderful mobility. Whereas a floating dock capable of lifting a modern liner or battleship would cost about £250,000, a graving dock would demand an expenditure of more than double this sum. Then the former could be built in a few months, whereas a masonry structure would take at least three or four years to construct. At Wallsend, a floating dock of 11,000-ton lifting capacity was completed within eight months of signing the contract. Unlike the fixed structure, the floating dock has the whole world before it, and should trade desert one port for another, it can easily be transferred, while the graving dock would remain idle.

There are two distinct types of these strange craft – the box dock and the self-docking pattern. The first-named is perfectly rigid, and therefore the stronger of the two. Should it become necessary, however, to clean or repair the underwater portions, it has to be placed in a dry dock. The self-docking type, on the other hand, is so designed that it can lift portions of itself out of the water, when they can be cleaned or repaired.

These floating cradles may be said to resemble a huge box, without ends or top. The bottom consists of a tank or pontoon, or several pontoons securely fastened together · and it is by filling these pontoons with water that the dock is sunk sufficiently to enable a ship which requires docking to be floated over the pontoons. The vessel is then hauled in between the walls of the

H.M. MEDWAY FLOATING DO

This wonderful floating dock of 33,000 tons, can lift battle cruisers of the "Orion" and "Lion" class

[illegible]

TOWED FROM THE TYNE BY FOUR TUGS

and dry out of the water in 2½ hours. Such a structure is the moving hospital of warships and giant liners

dock by capstans fitted on the tops of the walls. By powerful pumping machinery, located in the dock walls, the water is removed from the pontoons, and, as they are emptied, the dock rises gradually until the ship is lifted clear of the water. While in the dock the ship rests on keel-blocks, and is further supported by mechanical side-shores.

Medway Floating Dock

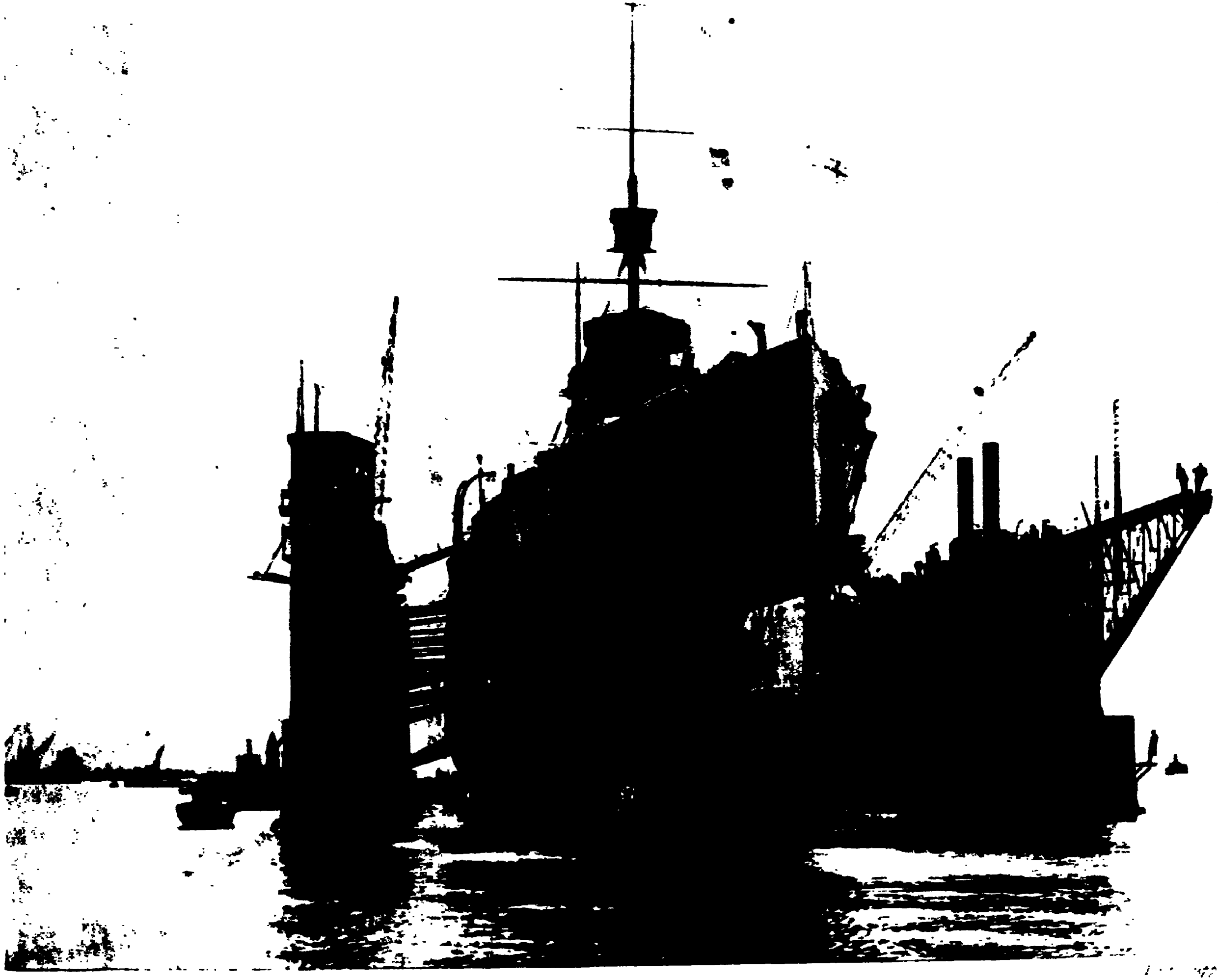
A description of the Admiralty dock in the Medway, which is of the box type, will give an idea of the wonders and capabilities of these floating contrivances. It has a total length of 680 feet, and consists of five parts, namely, three large pontoons and two side walls. These latter are 15½ feet thick, and have a height of over 60 feet. The dock has an entrance width of 113 feet, and a total width of 144 feet. The pontoons are divided into no less than sixty divisions. Running into each of these is a pipe and a valve, controlled from a central position known as the valve house. Standing there, the dockmaster knows exactly which valves are open and which are shut, and can regulate the descent and ascent of his craft accordingly.

The dock is lighted throughout with electricity. It possesses several powerful arc lamps for use when docking, or working on a ship at night. There are also special arrangements to facilitate the use of electric hand-lamps. On each wall there is a miniature railway on which runs a travelling crane, capable of lifting a weight of several tons. In the walls, too, are the living and sleeping quarters of the crew dwelling on the dock. Over 12,000 tons of steel were needed in the construction of this dock, while another 2,000 tons were requisitioned for her various accessories. This dock has raised battle cruisers of the *Orion* and *Lion* class in two and a half hours.

Good docking accommodation for a fleet in time of war is an absolute necessity. Here the floating dock has a great advantage over the rival masonry edifice, for it can be moved from place to place as occasion may require. It can work in a harbour or any sheltered position, and as the time required to berth a ship only occupies a few hours, quite a number of vessels can be attended to in a comparatively short space of time. All kinds of repairs can be effected upon it, for it is nothing less than a moving hospital, where the largest and heaviest ships can be made seaworthy without either having to be sent home or to some distant port. Indeed, in any naval engagement the commander who possessed such a handy means of docking disabled ships would have a great advantage over a rival who had to send his ships to their home ports for repair.

Exciting Work

Floating docks are invariably built complete at the yards, and then towed to their destination. This, on account of the enormous distances they have to travel, and the storms they encounter *en route*, often proves exciting work. Before now they have broken loose from the tugs and only been recaptured with great difficulty, while it was but a year or so ago that one became a wreck on the South African coast. From this country huge floating docks have been towed to Havana, in Cuba; to Durban, in Natal; to the West Indies, Brazil, Bermuda, and, more recently, to Callao in Peru, on the west coast of South America. What is regarded as the most daring towing feat on record was the conveying of the floating dock *Dewey* from Baltimore, in the United States, to the Philippine Islands. This unwieldy craft made the journey *via* the Suez Canal, thus covering a distance of 14,000 miles. During a storm in the Mediterranean she broke loose, and for three days was tossed about at the mercy of the waves.



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British Admiralty Battleship Floating Dock

This bow view shows H.M.S. "Lion" lifted. In time of naval war the commander who possessed such a handy means of docking and repairing disabled ships would have a great advantage over a rival who had to send his ships to their home ports for repair

Ocean Forests

Concerning the Monstrous Marine Growths which Lift their Heads 200 feet above the Ocean Bed

By FRANK T. BULLEN

Author of "The Cruise of the 'Cachalot'"

Photo by courtesy of "The Scientific American"

A Submarine Grove of Polyps

Drawn actually under water in the South Seas by Mr. Z. H. Pritchard

THERE does not, at first sight, seem to be any connection between the two words which stand above, for it is not easy to imagine what forests can possibly have to do with the "salt, unplumbed, estranging sea." A little reflection, however, will serve to bring to the memory of most people the masses of marine vegetation piled upon the sea-coast after a storm, much of it bearing obvious marks of having been torn from its root-holds on the sea-bed by the violence of the waves before being flung ashore. Yet, even then, the majority of observers would refuse to credit the propriety of calling the submarine plots where that seaweed grew by the dignified name of forests. If for no other reason, the shortness of the plants in even the heaviest masses would forbid the right of their habitat to be called by any more sounding title than ocean pastures; and that again presupposes that this sea vegetation affords nourishment to numbers of marine ruminants, which is certainly not the case.

Still, the sight of those immense masses of sea wrack and tangle piled upon remote beaches after a storm will prepare us to believe that far away in the Southern Seas, around lonely islets rising from awful depths, mountain peaks just emerging from a vast waste of stormy ocean, there are to be found veritable ocean forests, properly and justifiably so-called. Around the rugged shores of the Falkland Islands, Tristan d'Acunha, Gough Island—to name only three out of very many—these mighty oceanic forests spring, not from vast depths, of course, but from the mysterious flanks of the mountains, whose tops, aspiring from the waves, form the islands.

Only those who have ever entered one of these forests can form even a remotely adequate idea of their grandeur, of their immense extent, and some, at least, of the

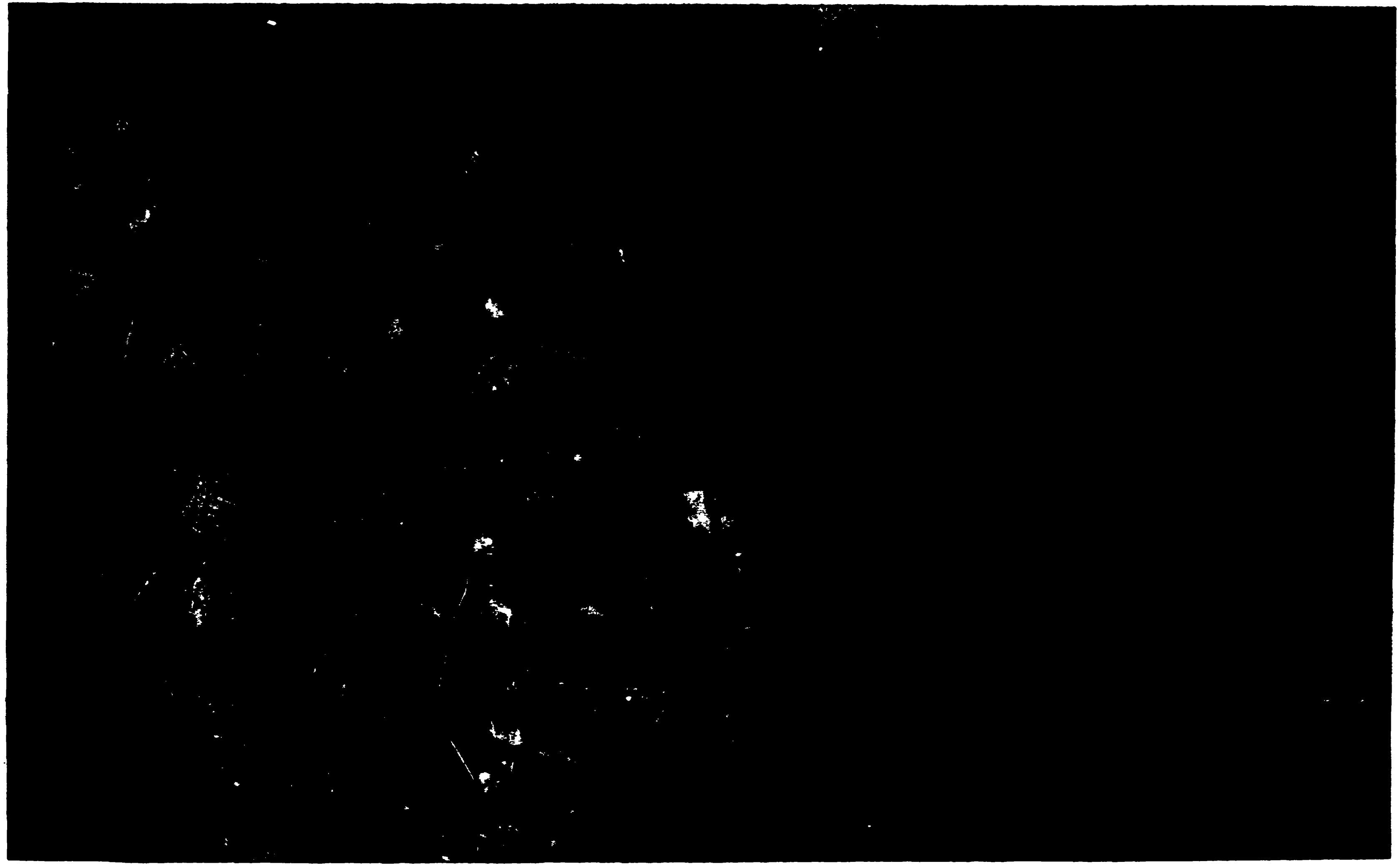


Photo by courtesy of the American Museum of Natural History

The Teeming Life of the Deep

The very provision of shelter induces an enormous population of the sea-people to make it their home. When even a wharf pile (as shown here) is [illegible] what must the population of the ocean be!

Photo by courtesy of "The Scientific American"

Sand Heaps on the Bed of the Sea

Drawn by Mr. Z. H. Pritchard. Here the fish find shelter from each other, places to hide, places to spawn, and abundance of food

purposes they subserve. Their fleshy stems, black and glistening, rise sheer from the bottom for hundreds of feet, spreading their broad brown leaves in every direction, and breaking the fiercest fury of the Southern Ocean waves far more effectually than could the most massive breakwater of granite. For a distance from the shore, varying according to the steepness of the slope of the submerged mountain, the great fronds fill the whole sea-space, and within the charmed circle they make around the island the waves have no power, the water is as smooth as if its surface were oil. It cannot be otherwise, for there is not a vacant square foot of sea to be seen; the summits of the ocean trees spread their leafage so as to cover it effectually.

To what length these monstrous marine growths do really reach is not accurately known, but I have heard several hundred feet spoken of, and I have myself seen pieces 200 feet long. Two hundred feet of branchless tree out of whose straight stem grow the great leaves unwaved and still in the quiet waters beneath, for they are only ruffled on the surface by the onrush of the seas or the labouring boatmen, hauling their craft through them to the shore with immense labour. These stems grow thickly in some places, sparsely in others, according to some unknown law, but none of them appear to suffer from overcrowding, however thickly they may grow.

On a fine day, with the sun shining brilliantly overhead, it is delightful, having made a clear space by gathering a few fronds into the boat, to gaze down into the pellucid depths and watch the fauna—the fishy inhabitants of this weird forest—disporting themselves. Here they find shelter from each other, places to hide, places to spawn, and abundance of food, because the very provision of shelter induces an enormous population of the sea-people to make it their home. Consequently, there are more to devour, although the smaller and more feeble the fish, the better sheltered they are, moving about being more difficult as the inhabitants increase in size, until the whales, the largest of all, shun the vicinity of these ocean forests altogether.

As far as it is possible to observe, these ocean trees do not themselves afford any food to any denizens of the deep whatever, unless, perhaps, it be some of the humblest and lowest in the scale of oceanic life. But like all things in the deep sea, much of the history of the gigantic kelp is deeply mysterious, perhaps in nothing more so than in the capriciousness of its habitat. One group of islands or single islet will be completely sheltered by it, unapproachable by any vessel save small boats; another will be bare; and no great expanse of sea lies between those thus favoured and those not so clothed.

It is hardly a stretch of language to call the accumulation of the Gulf, or floating weed in the great eddy of the Sargasso Sea an ocean forest, although the plants are feeble individually, and have no root-hold upon the bottom. All ocean travellers over the North and South Atlantic are familiar with the appearance of this graceful ocean vegetation, but few, indeed, there are who have seen it where it lies in densest masses, for the simple reason that no vessel goes there unless and until humanity has ceased to control her. In the old days of seafaring, sailing vessels often found themselves laboriously pushing their way through dense masses of the weed, the ocean having completely changed its colour to a golden yellow, like that of ripe wheat. But your modern steamship could not possibly force her way through such masses, because, apart from the tremendous extra strain upon the propeller, all the indispensable inlet valves would choke, and render the vessel helpless.

Photo by courtesy of "The Scientific [illegible]"

A Submarine Glade

Drawn by Mr. Z. H. Pritchard in 40 feet of water, off the west coast of Scotland

IV.—In the Depths: Natural

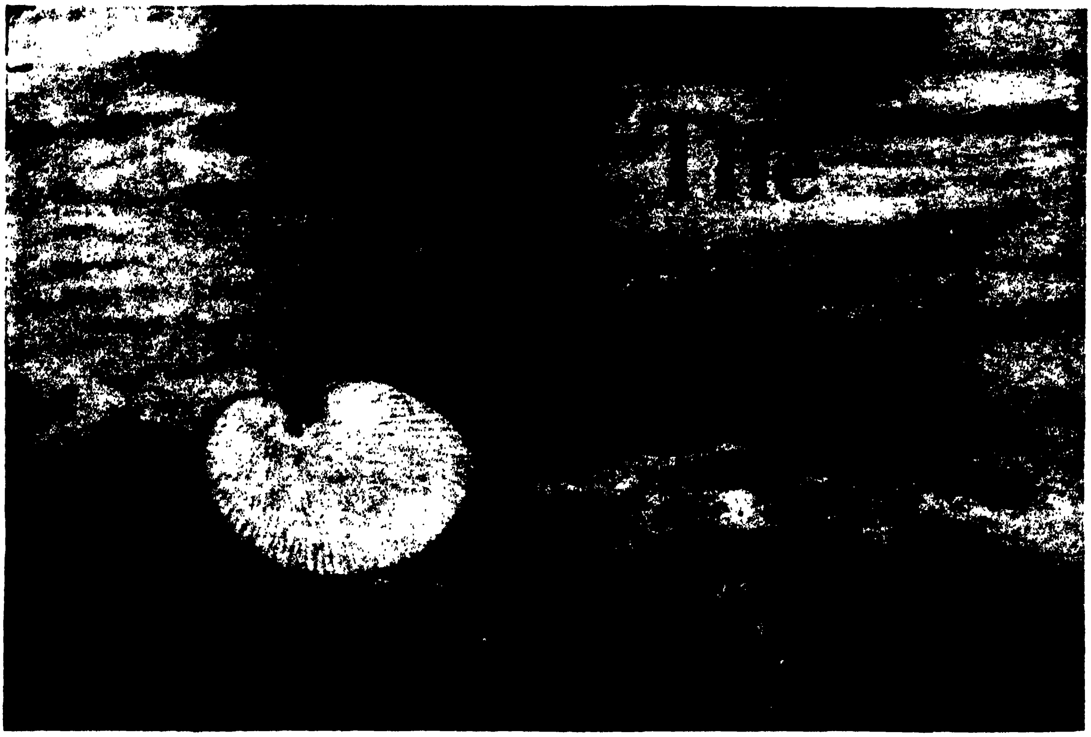


Photo: H. J. Shepstone

Shell of the Argonaut on the Shore of Santa Catalina Island

The Truth about the Paper Nautilus—famous from Earliest Times as an Ocean Navigator

A WELL-KNOWN zoologist, Professor Charles F. Holder, of Los Angeles, California, possesses a unique pet, a paper nautilus or argonaut. In many respects this is a strange and wonderful creature—the most remarkable and interesting of the whole mollusc family, from the fact that it is not organically attached to its shell, which it can leave at will, and then return to it. Being a habitant of somewhat deep water, and only coming to the surface at certain periods, zoologists and others have not hitherto had much opportunity of making themselves familiar with it. Thus, Professor Holder, by taking one of these little sea creatures and taming it, has been able to add appreciably to our knowledge concerning its quaint habits.

The existence of the paper nautilus, of course, was known to the ancients. Indeed, it is often referred to in literature and in the classics. All the nereids, mermen, and mermaids were apparently familiar with it, and Father Neptune is often depicted riding in one of its beautifully-formed shells, whose graceful lines and convolutions have appealed to poets and writers in all ages. Dr. Johnson refers to this creature when he speaks of the sea-born Venus which "sportive dolphins drew," while Aristotle credited it with the power of lifting its web-like arms and sailing before the wind.

Thus the paper nautilus has been regarded as having given to man the first lesson in the art of navigation. It has generally been represented with six arms extended over the sides of its little vessel to act as oars, and two others upraised as sails. Byron speaks of "the tender nautilus who steers his prow," and Pope bids us "learn of the little nautilus to sail," while

The Argonaut

other writers and poets have raved over the alleged sailing propensities of this wonderful little creature of the ocean. As a matter of fact, it never moves in this way, and although competent authorities by careful and patient observation have shown that the nautilus does not sail before the wind, the average layman to-day still believes that the argonaut raises its arms, when upon the surface, and is carried along by the wind, which shows the influence of poets and the duration of poetry.

This particular creature is called the paper nautilus from the paper-like delicacy of its shell, which breaks up at once on the beach, being ground to pieces by the action of the waves. It swims backwards by ejecting water from its funnel-shaped mouth, like the cuttle-fish. It can creep along the bottom of the sea, carrying its shell upon its back like a snail, and, like many other molluscs, it can rise to the surface. When there, however, the arms are never employed as oars or sails, the creature merely floating along on the bosom of the ocean.

Photo: H. J. Shepstone

Argonaut at Home

This remarkable photograph shows a tame paper nautilus peeping from its shell

The beautiful, translucent, ribbed shell of the nautilus is the work of the female. It is formed or built up by secretion from its two larger arms, which are much bigger and broader than those of its six other tentacles. In this receptacle, which the creature can evolve in a single night, and into which she retires when alarmed, the female deposits her eggs. Still the shell is more of a cradle or a nest for the eggs than a home, being too soft to protect the animal from the attacks of larger fish, or even from the action of the waves. When out of its shell it resembles, at first sight, the octopus, but is really one of the most beautiful of animals on account of its varied and delicate colours, which it can change at will.

Writing of his interesting pet, Professor Holder says: "The animal was brought to me without a shell, so I provided one for it. It seized upon it with all the eagerness of a homeless hermit crab, occupying it at once. When alarmed it would crouch low, its entire body and tentacles drawn into the shell; nothing but the green eyes to be seen peering over the edge. Then, when satisfied that all was well, it would gradually come out, changing tint and shade of blue all the time, presenting a most interesting spectacle. Now the two large shell-forming arms would creep out and slowly envelop the shell, until it was entirely covered by the speckled blue mass. The animal would do this even when I held the shell. It did not display any fear, and would throw its tentacles about my fingers, and even leave the shell and permit me to handle it."

One of our photographs exhibits the nautilus entirely out of the shell. "When I removed the latter," says Professor Holder, "the creature fastened itself to the glass sides of the tank and hung, a glistening mass of colour, scintillating in the light. Not one person out of a thousand could even guess what it was. Even teachers of zoology failed to recognise it, which was natural, perhaps, seeing that this was the first opportunity they had had of studying the animal alive. By placing a cloth over the tank, and raising and lowering it, the nautilus could be made to change its colour."

Professor Holder had an opportunity of observing the shell-making work of this interesting little animal, and on this point he says: "Resting on the bottom of the tank, it held its two shell-secreting arms above, side by side; in point of fact, they were joined at the base. Then from the glands oozed the shell-making secretion, and it soon appeared as a gelatinous cast of each tentacle, the exact size of the shell the animal had been inhabiting. The radiation on the face of the tentacles made the radiations on the shell, and one could imagine that gelatine had been pressed into the moulds and allowed to harden.

"This is practically what is done. The two moulds (tentacles) are held up close together; the left one forms the left side, the right one the right side. Then by manipulation they are joined together. Indeed, the two tentacles have been joined all the time, and so form a mould in which the beautiful shell or egg capsule is made. I watched this radiant creature all day and late into the night, and the following morning part of the new shell was found, a delicate, tenuous mass, that would gradually harden. Hence I believe that a new and large shell can be produced in a few hours.

"It is given in all the text-books, I believe, that the male of the argonaut is a minute animal hardly an inch long. This cannot be so in all species. I once had a male in my possession which had a radiant spread of eight or nine inches, and was as large as the females. The latter live in the shells and deposit their eggs there, yellow masses which hang in delicate clusters from the inner covering. When the eggs are hatched the nest is deserted, the normal life of the nautilus being, I believe, a shell-less one.

"Altogether I have kept three argonauts in confinement, and found them most interesting. Specimens seen in alcohol are white and faded, but my argonauts were garbed in glorious lavenders and blues, with touches of rose and gold of a brilliancy and beauty beyond expression. Their tints were continually changing, darkening, fading, gleaming in iridescence; now black or blue-black, now a beautiful rose or deep scarlet, but nearly always a blue of infinite delicacy and beauty. I could produce these changes by aggressive movements, the resultant play of colours being most remarkable.

"All of them would eat fish from my hands readily, and were easily tamed. When alarmed they would dash away, filling the water with ink and propelling themselves by the siphon, out of which they sent water with such force that when held above it, the stream would go five or six feet through the air. In watching these animals, particularly when moving along the surface of the tank, one can readily understand how the classic tales of the oars and sails of the craft of Venus came to be believed, and one also sees that truth is just as interesting and fascinating as fancy."

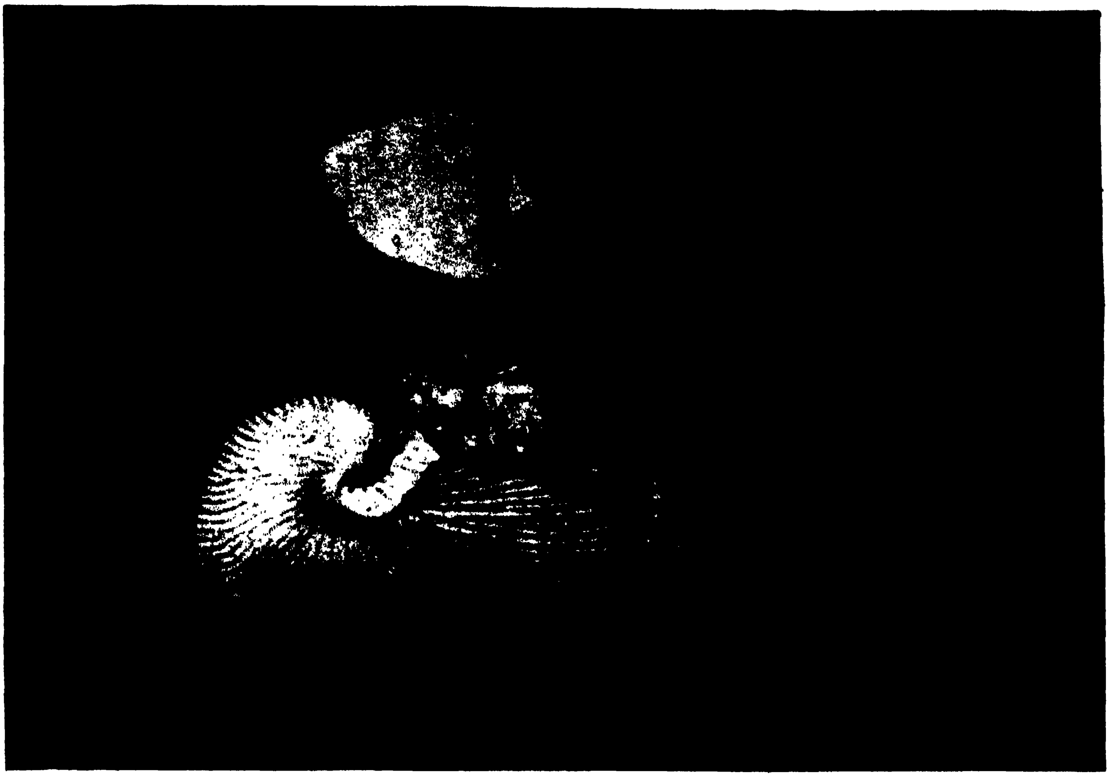


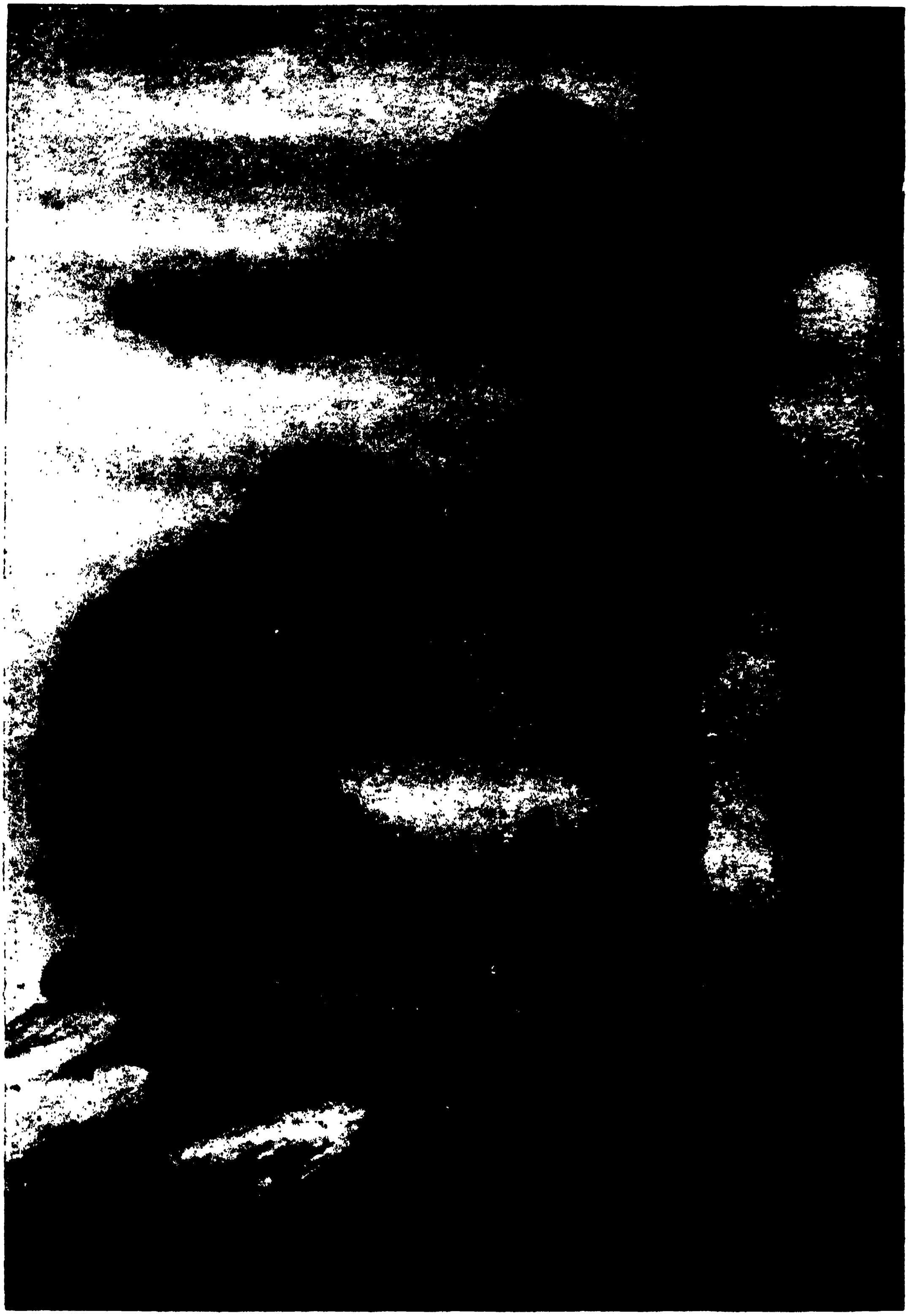
Photo: H. J. Shepstone

The Argonaut Partially Out of its Shell

Photo: H. J. Shepstone

The Argonaut Entirely Emerged from its Shell

Living argonauts are garbed in glorious colours—lavenders and blues, with touches of rose and gold—of a brilliancy and beauty beyond expression



Drawn by Arthur Twidle

The Spectre of the Brocken

An enormously magnified image of the observer, cast upon a bank of mist, is sometimes seen in high mountain regions when the sun is low in the heavens and the observer is between the cloud bank and the sun; it is seen oftenest in the Harz Mountains

Colours of the Sky

Is the Sun really Blue? How Man has Learned the Secret of the Glories of the Heavens

By ARTHUR HOLMES, F.G.S., A.R.C.S.

Author of "The Age of the Earth"

TO those who love the varying moods of Nature, the ever-changing pageant of sky and cloud, sunrise and sunset, is a source of perpetual wonder and interest. Yet, as Ruskin lamented, "It is strange how little people in general know about the sky." How many of those who bathe their eyes in the limpid beauties of the sky could give an explanation of the deep blue dome of heaven or of the rich glows of crimson and gold which streak the western sky at sunset?

The blue of the sky was for long one of the standing enigmas of meteorology. Why should the atmosphere, which is made up of an intimate mixture of transparent and colourless gases, appear to be blue? Some of the early writers denied that it was really colourless, and asserted that blue was the natural colour of thick masses of air. But if this were the case and the earth were enveloped in a gaseous mantle of blue, it is obvious that the colour should be deepest on looking towards the setting sun, for we should then be receiving the light through the greatest possible thickness of air. Moreover, distant snow-clad mountains, throwing back the light which falls upon them, would also appear to be blue.

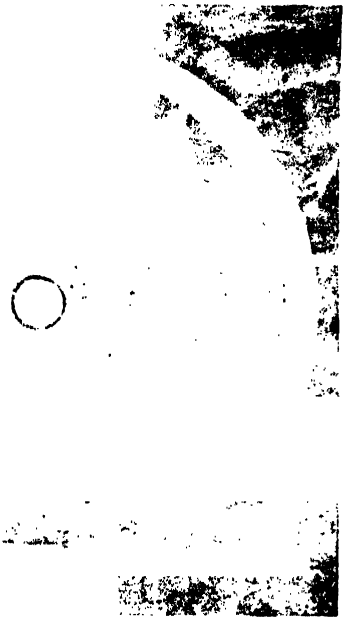
On the contrary, the rays which spread their rosy colours over the mountain snows, and tip the ripples of the clouds with gold, are just those rays of sunlight which remain when the blue of the midday sky has been abstracted.

There must, however, be something in the atmosphere which scatters the solar rays. Otherwise we should be surrounded by the blackness of infinite space, and, the moment the sun dipped below the horizon, the earth would be plunged into sudden darkness. No twilight would awaken us to the poetry of eventide; no after-glows would ravish the eye of the artist. Virgil would never have written of the sky as "The ethereal arch, pregnant with perpetual

A Halo Round the Moon

In looking up to the sky, the light which comes to our eyes is not ordinary sunlight such as is reflected from the moon change, from the morning's purple dawn to the last glimmering rays of russet eve.”

It was suggested long ago that the particles in the atmosphere which send the gorgeous colours to our eyes were thin bubbles of water. The colours of a soap bubble dancing in the sunlight, the shimmering beauties of a precious opal or a polished shell, and the gaudy lustre of a thin film of oil, are due not to any intrinsic colour of the object itself but to the very thinness of the material in which the colours are born. But how could thin films of water be formed and sustained in the atmosphere ? The theory will not work, for the blue of the sky is a very different colour from any of the half-dozen tints of blue which arise in the molecular network of a bubble.



A Halo Round the Sun

If the sun could be seen outside the atmosphere it would be a blue sun

It was the late Professor Tyndall who first successfully imitated the blue colour of the sky, and Lord Rayleigh who explained the delicate mechanism of the process. Not bubbles, but only tiny colourless particles are necessary. What they are made of does not matter. Fine dust carried up into the air from the earth; infinitesimal specks of lava blown from the crater of a volcano; particles of salt derived from the spray and sea-fret of a storm; water vapour condensed into minute liquid globules or invisible crystals of ice; meteor-dust produced by the burning of a shooting star as it flashes through the atmosphere; and even the molecules of the gases of the air; any and all of these will serve the purpose. Extreme smallness of size, far below the resolving power of a microscope, is the sole condition for the creation of sky-blue.

Tyndall produced an artificial sky by passing a beam of light through a tube in which purified air was mixed with a little vapour of iodide of allyl and hydrochloric acid. For a time nothing takes place, but gradually, by the action of the light, the vapour is decomposed and the molecules coalesce to form a fine cloud of particles so small that their diameters do not reach a millionth of an inch. Slowly a delicate blue colour is generated, and as the particles condense a splendid azure is produced “ which rivals if it does not transcend, that of the deepest and purest Italian sky.”

Presently the cloud grows coarser, the particles are no longer competent to scatter blue light alone, and a whitish tint like a veil of mist mingles with the blueness of this little patch of sky.

The explanation of this elegant experiment lies in the relation of the wave-lengths of the visual rays of light to the dimensions of the particles floating in suspension in the tube.

A cork dancing on the open sea offers no obstruction to the larger waves. It rises and falls with the roll of the water, and the waves pass on unaffected by its presence. In the case of ripples, however, the cork proves to be an effectual barrier. The ripples break against the side of the cork which takes up their energy and swings a little from side to side. In place of the original ripples a circle of tiny wavelets is scattered from the sides of the cork. If now we substitute ether waves for sea waves, and an ultra-microscopic particle for our cork, the production of a blue colour may be readily visualised. The longer red waves roll smoothly on, for the minute particle is incapable of turning them aside. Not so, however, with the shorter waves corresponding to the colour blue. As they splash against the particle they are scattered from its sides in an ever-widening circle of blue.

Photo: Sir H. H. Johnston

A West Indian Sunset

This actual photograph of a sunset in Nassau, in the Bahamas, conveys but a faint idea of the glories of coloration which the sky exhibits as the sun sinks out of sight

In the experimental tube the white light which falls upon the vapour is at first unscattered, and the tube appears to be empty. The luminous cloud which generally maps out the path of a ray of light in a darkened room has not appeared, for as yet the particles are too small to turn aside even the shortest waves. As the particles slowly grow, they reach the requisite dimensions for scattering blue rays alone. But soon a whitish tint appears, announcing the fact that growth has proceeded beyond the limit for blue and that all the colours from blue to red are present in the scattered light.

In looking up to the sky, the light which comes to our eyes is not ordinary sunlight such as is reflected from the moon. The sunbeams which pass through the upper reaches of the atmosphere meet with myriads of the tiny dust particles already mentioned, and the blue rays are sifted out and sent off more or less at right angles to the former direction of the light. Thus, the rays which come from the dome of the sky are rich in blue, and the rays which pass on through the atmosphere are correspondingly enriched in red. In the same way the blue veil of a distant mist, or the curling smoke of a cigarette, receives its almost intangible colour. The pale bluish tint of milk and water, and the deep azure of a chalk-laden stream are due no less to the same cause.

In the lower reaches of the atmosphere some of the dust particles are relatively coarse, and reflected white light is added to the scattered rays of blue. For this reason the sky near the horizon is paler than in the zenith, for the light received by the eye has passed through the lower dusty air, and the deep blue of the celestial dome is to some extent overpowered by a whitish haze.

A Blue Sun

Looking towards the sun in the open sky our line of sight is more nearly in the direct path of the solar rays, and the proportion of blue which reaches our eyes is much reduced. Indeed, we come here upon a curious fact. Why does the sun appear to be white at all, if in their passage through the air its rays are deprived of their bluish elements? If our previous reasoning is correct the sunlight which reaches us directly ought to be not white but of a ruddy tint. We are therefore led to the conclusion that if the sun could be seen outside the atmosphere it would be a blue sun. It appears to be white only after its excess of blue has been sifted out by the atmosphere and its load of ultra-microscopic dust.

When, however, the sun is viewed on the horizon its disc actually takes on a red or orange hue. The rays are then deprived not only of their excess of blue, but also of some of the blue which is necessary to the production of white light, for the direct rays of sunlight from the western sky are viewed through a much greater thickness of air than those from the midday sun.

It has already been stated that even the molecules of the air-gases are competent to pick out the blue rays of sunlight and disperse them. Observers in high mountain districts describe the colour of the sky as a deep indigo, and above a height of about 20,000 feet the illumination is so much reduced that it appears to be almost black. It is this deep pure colour which is born in the atmosphere itself.

Avogadro's Constant

One of the most astonishing features of Lord Rayleigh's theory of the molecular scattering of light is that it leads to a reliable estimate of the number of molecules in a given volume of air. Since the theory satisfactorily accounts for the puzzling facts of skylight, it has been deduced that each cubic centimetre of air (or indeed of any gas) under standard conditions of temperature and pressure contains twenty-five millions of millions of millions (25×10^{18}) of molecules. Now this number, which is known as Avogadro's constant, has been estimated in many other ways. Rutherford and Geiger have actually counted the number of atoms emitted from a specimen of radium in a given time, and having further measured the volume of the gas, helium, which accumulated, they were able to prove directly that each cubic contimetre contained twenty-seven millions of millions of millions of molecules (27×10^{18}). It is a striking testimony to the exquisite accuracy of modern physics that phenomena so remote as radio-activity and the colour of the sky should lead to such an extraordinary consistency in the determination of Avogadro's constant—a number so vast as to be in itself absolutely inconceivable.

It will now be clear why the lower western sky becomes a gorgeous blaze of crimson and orange as the sun sinks out of sight. The observer receives only the rays which have passed horizontally for a great distance through the atmosphere, and have consequently lost their blue constituents. Looking *across* the sunset rays the blue haze of distance is seen veiled across the hills. Overhead, where the crimson glows

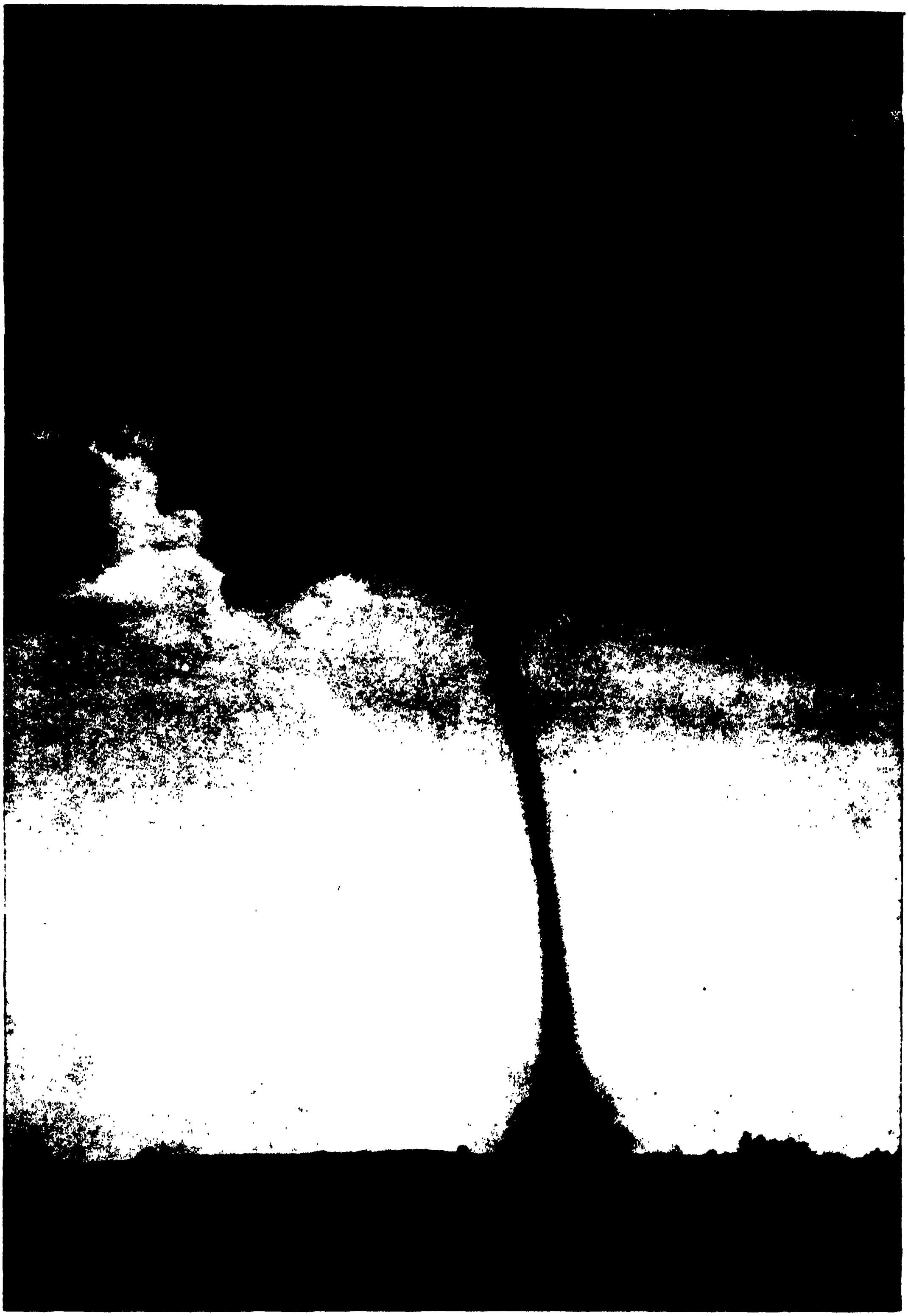


Photo T. Campbell

A Terrible Whirlwind at Roodegsvort, near Johannesburg

A destroying sword like this, which dealt destruction through a peaceful countryside, or the eruption of a volcano, causing fearful loss of life—such things, by raising dust particles into the sky, provide the raw material for azure heavens and gorgeous sunsets are travelling horizontally and unseen, the blue rays are still turned earthward, and the sky is blue except where the loftiest clouds have caught the rosy tints and bathed themselves in glowing colours.

Sunset Colours

As the sun dips below the horizon the wealth of colour increases greatly, spreading its radiance over the clouds and the distant snow-clad mountains. Above the now invisible sun extends the sunset-glow, centred with silvery white and passing upwards through successive belts of amber and lemon, and of delicate tints of rose and purple, to the darkening blue of the advancing twilight. To the north and south of the point of sunset, the glowing yellows pass into blue through limpid tints of green. In northern countries, and especially in cold dry weather, the prevailing hues are soft and delicate tints of yellow and green, imperceptibly mingling with the limitless blue above. In the tropics and in northern latitudes on the advancing fronts of storm belts, wild angry skies are more characteristic, burning with golden yellows and lurid reds. No artist has represented better than Turner the gorgeous beauty of a stormy western sky, steeped in liquid gold and fiery crimson and mantled in a garb of glowing cloud.

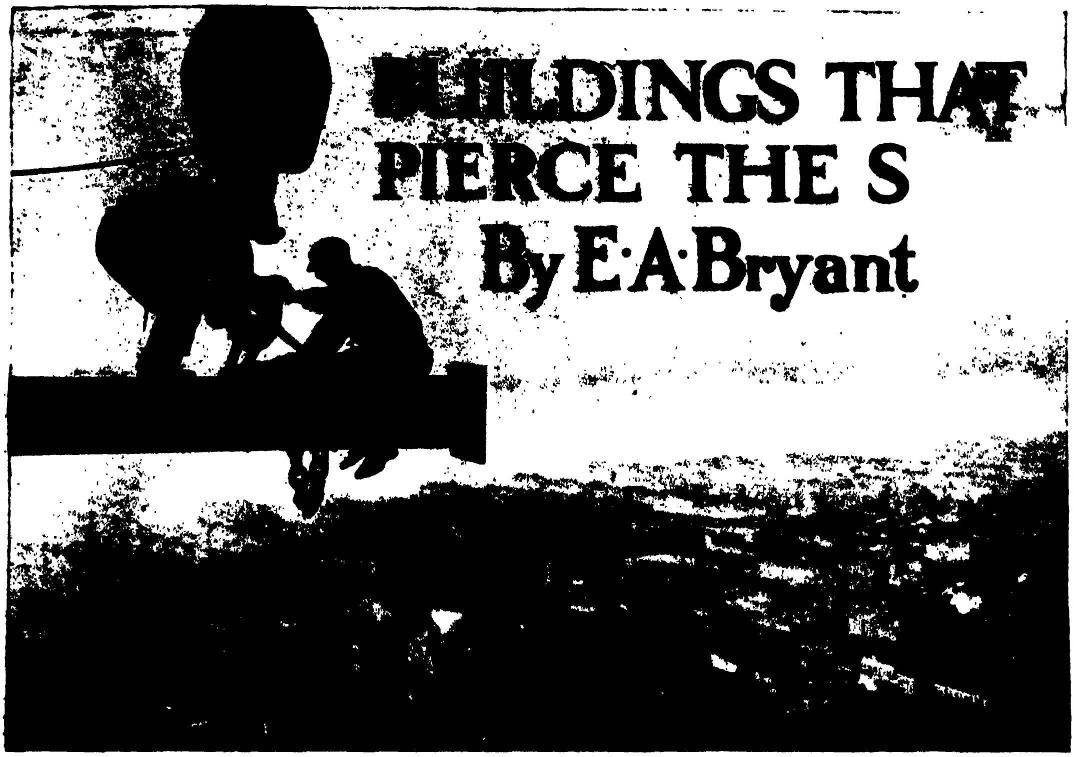
The first glow gradually increases in brilliance till the sun is about four degrees below the horizon. It then begins to pale until, when the sun has sunk a few more degrees, it fades away altogether. In very clear, dry weather, a second afterglow may be seen for a short time, a faint ring of rosy or purplish light which has its origin in the lofty layers of the atmosphere which are still above the earth-shadow of the twilight. Similar glows are to be seen before sunrise as the dawn " with silver-sandalled feet " mounts in the eastern sky. The colours are in general more delicate than those of the flaming sunset skies, and the tender shades of pink or lavender flanked on either side by lemon yellows and the palest of fathomless greens are often softened by the silvery mists of the morning sky.

In conclusion, a brief reference may be made to the extraordinary sunset glows which illuminated the sky in the autumn of 1883, and during the two following years. A series of brilliant sunsets followed the stupendous eruption of Krakatoa on August 27, 1883, when 8 square miles of the island were blown away. Pumice-dust spread over the sky, and produced a pall of darkness for hundreds of miles around. The very finest particles of the dust cloud rose high into the atmosphere, and were caught up by air currents and carried rapidly westward, completing the circuit of the globe in a fortnight.

Soon after, the sun appeared as a greenish disc, and green-tipped clouds mingled with the vivid reds and yellows of the sky. In the west a strange silver glare was reflected from the thin films of volcanic glass which constituted much of the dust of that amazing outbreak of plutonic energy. The sunset glow became visible throughout the day, so brilliant as to be seen, not only after sunset but even in the midday sky, as a dusky crimson radiance encircling the sun.

Dust-made Beauty

After sunset the whole sky was lit up as with the lurid reds of a world-wide fire, and the whole gamut of sunset colours, caught by the dust far up in the atmosphere, passed across the sky from east to west as the earth rolled into the night. The dependence of atmospheric colours on the dustiness of the air is illustrated by many local peculiarities, such as the pink skies and red twilights which are seen in Egypt on the borders of the desert, but for wealth of colour and vividness of illumination the Krakatoan skies remain unrivalled. Remembering the dread cause of their unnatural brilliancy, we may perhaps remain content with the softer shades which paint the evening sky with beauty in our, happily, less eventful land.



BUILDINGS THAT PIERCE THE S

By E·A·Bryant

[illegible] H. [illegible] Shepstone

Workmen on Woolworth Building, New York

How Modern Engineers Out-Babel Babel—The Blondins of Industrial Life who Work Among the Clouds

WITHIN the lifetime of those whose years still run in the twenties the world has witnessed a very striking revolution. It has witnessed the creation and development of a form of building known to us all as the skyscraper. Since the Great Pyramid was built in Egypt nothing so astonishing as these cloud-capped towers of metal, stone, and concrete have been raised by the hands of man. They possess no beauty save that special beauty which immensity may confer, yet they challenge and arrest the imagination by their colossal audacity, by the daring genius which designs them, by the suggestion of dauntless courage on the part of those who carry the designs into effect.

A special school of architects and a special school of builders have been necessary to bring these gigantic structures into being. For they are new, unprecedented, unforeshadowed by anything that went before them. The transition from the old style of building to the cloud-catcher is as swift and abrupt as that marvel of change noted in the difference of style characterising Peterborough and Lincoln Cathedrals. The former is the last of the Norman fanes, the second the first of the Early English. Only a few years separated the completion of the one and the beginning of the other, yet architecturally they are centuries apart. Just as marked is the contrast between the skyscraper and all that had preceded it. The nearest suggestion to a precedent is our own Crystal Palace, the first of great steel-framed edifices; yet how vastly unlike it are its possible descendants, the dizzy Flat-Iron building, the Metropolitan of New York, the monstrous Woolworth.

Photo: Underwood & Underwood

"Plenty of Ground in the Sky!"

Not content with the Flat-iron Building shown here, or the monstrous Woolworth, American engineers dream of one 2,000 feet high, with 150 storeys

Necessity, the mother of invention, brought the skyscraper. The new idea was launched at Chicago and New York almost simultaneously. There is a shortage of land in the business quarters of both cities and barriers in the way of extension of area, so, instead of attempting to build out over the ground, two men, almost at the same time, resolved to build high into the air.

"There is plenty of ground in the sky!" they said, and both began the erection of steel-framed buildings, climbing cloudwards storey upon storey, floor over floor.

It was a relatively small beginning, only a matter of half a score of storeys, and the architects of those buildings are held to-day not to have been able to "skyscrape" worth mentioning. But it inaugurated a revolution of enormous potentialities. It raised the price of land in the business heart of New York to £120 the square foot, but it brought down the price of building material for a complete edifice from a sovereign to two shillings the cubic foot; it enabled the owner of hotel and offices to house the population of a moderate-sized city under one roof, and to levy toll representing a handsome profit upon expenditures of hundreds of thousands of pounds.

It is impossible to avoid contrasting these new wonders with the Pyramids. Engineers and archæologists fret and quarrel over the methods by which, they suppose, Cheops raised his mighty pile. Frankly, nobody is positive about the matter. Now, if history were again to nod, and a new generation arose that knew not President Woodrow Wilson, nor the wonder-working ways of his age, the method of building the skyscraper would be a mystery still greater than that in which the origin of the Pyramids is wrapped. There are hundreds of feet of solid rock under the Pyramid, and only an earthquake could move its foundations. But these American marvels are stepped in soft soil; they run through water, through shifting sand, through fissured rock; and the means of getting a firm foundation are as various as the media in which they are placed. In Chicago they borrow a lesson from old England and float their buildings, as St. Paul's Cathedral is floated, upon rafts of piles. Where dry soil is encountered, they enclose the foundations within titanic containing-walls of concrete.

In other strata they employ huge caissons over which the weight of the superstructure is distributed by a grillage of steel girders. Upon these the steel columns for the building rise. The plan is ever changing, constantly improving, but in general principle the scheme is broadly the same. As the columns are erected, cross beams and girders are fixed in position. As the level for each floor is completed, so additional workers are put on to race forward with the task of filling in the details of the building, of which the steel frame is the skeleton. At first, speed in building was the one desideratum, but since a structure of ten storeys collapsed in a gale, slaughtering all the workmen engaged upon it, care has been made an added consideration. To this end an astonishing variety of mechanical contrivances has been invented.

Tier upon tier of cranes do the lifting and placing in position of the materials used; cranes upon iron platforms, upon the summits of towering, dizzy derricks, conveying beams and girders to men precariously perched upon swinging scaffolding, or balancing themselves in positions high in the air where, at first sight, one would say that nothing but a bird could preserve a foothold.

Hand labour is reduced to a minimum: cranes, pneumatic tools, electric drills, and what not spare the hand and ease the muscles. But, with every aid, a man must be a sort of industrial Blondin to share in the labour of building a skyscraper. They are all super-steeplejacks, creeping about in mid-air on narrow planks, upon slippery

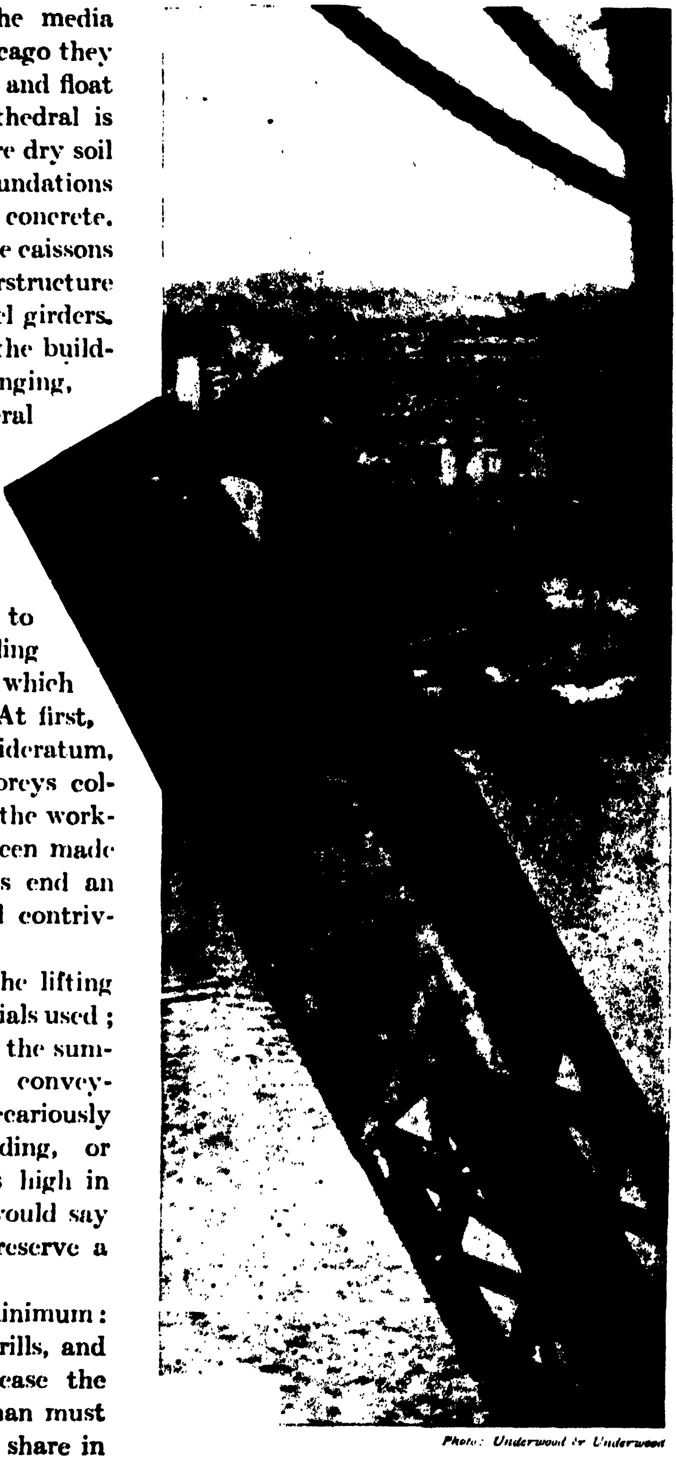


Photo: Underwood & Underwood

An Industrial Blondin

Nothing but iron nerve preserves these super-steeplejacks from an awful death metal, with nothing but iron nerve to preserve them from being dashed to instant death, hundreds of feet below.

There was a distinguished young man, upon a time, who had to quit the Italian army because, when he mounted his horse, vertigo caused him to fall. "You have more the face of a priest than of a soldier," said his superior officer, and, taking the hint, the young man renounced the uniform for the cassock, and became Pope—Pius IX. The man who turns dizzy upon a skyscraper has only death to expect. For the heights of these buildings are such that we have really no standard of comparison in this country. St. Peter's, at Rome, the highest building of the character in Europe, is 484 feet high. If St. Paul's were piled upon St. Peter's the height of both would only then equal that of some of the latest of American steel-frame buildings. Think of the loftiest warehouse or factory you know in London or Manchester, or any other great city—six or seven storeys, perhaps—then multiply the height by seven or eight, and allow for a huge tower overtopping that, and you get the altitude of a modern New York cloud-catcher.

A Worm's-Eye View

It is impossible for the man in the street to appreciate the immense height to which the skyscrapers tower above him; he gets but a worm's-eye view. And he does not see the whole. The underworld of these self-contained cities runs deep into the bowels of the earth. The great £600,000 Singer building, which rises in forty-one storeys, 612 feet above the kerb, has cellars and foundations over 200 feet deep, so that the total height, from bedrock to cupola, is 815 feet, and the weight of steel alone in it represents 8,000 tons. The Metropolitan Life building stands 70 feet higher than the Singer, and the latest, the Woolworth skyscraper, with its fifty-five storeys, is 750 feet high. The Equitable was to have been made 909 feet in height, but the scheme was modified five years ago.

Men of Nerve

Those are the elevations at which these men of marvellous nerve carry on their work, fixing bolts and ties up in the rarefied air, to which the dust does not ascend, and into which even the flies do not venture. Of course accidents are frequent, and deaths unhappily common. That is always the case with engineering schemes such as these. The Forth Bridge involved 57 deaths, and injuries to 378 men, although in Great Britain we are, in respect of care for our men, the most solicitous engineers in the world. Many terrible things happen up among the network of swaying platforms and trembling unfixed beams in these aerial horrors.

Picture the hideous tableau recently presented on a San Francisco skyscraper, when one of the steel workers, poised upon a steel beam seventeen storeys high, missed his footing, and fell. With a penetrating scream he dropped, but managed, with frantic fingers, to grip a narrow ledge of steel. He hung there swaying, while a comrade, stepping nimbly along the beam rushed to his rescue. The rescuer dropped on one knee, reached down his right hand, and clutched the fallen man by the collar of his overalls, just as the nerveless fingers of the other relaxed to leave him swinging in a dead faint in space. Kneeling on a four-inch beam of steel which quivered in a high wind, sustaining by one hand the man below, the rescuer clung desperately while he shrieked for aid. And somehow, from somewhere, help came, from below and from above, to save the unconscious man as he fell from the paralysed grasp of his comrade, and to reclaim the latter from the terrible position in which by his heroism he had placed himself.

It is all in the day's work. Peril and performance bring a pound a day, and it is that which matters to these strangely daring men of new type whom the skyscraper has evolved.

They are proud of their occupation, as

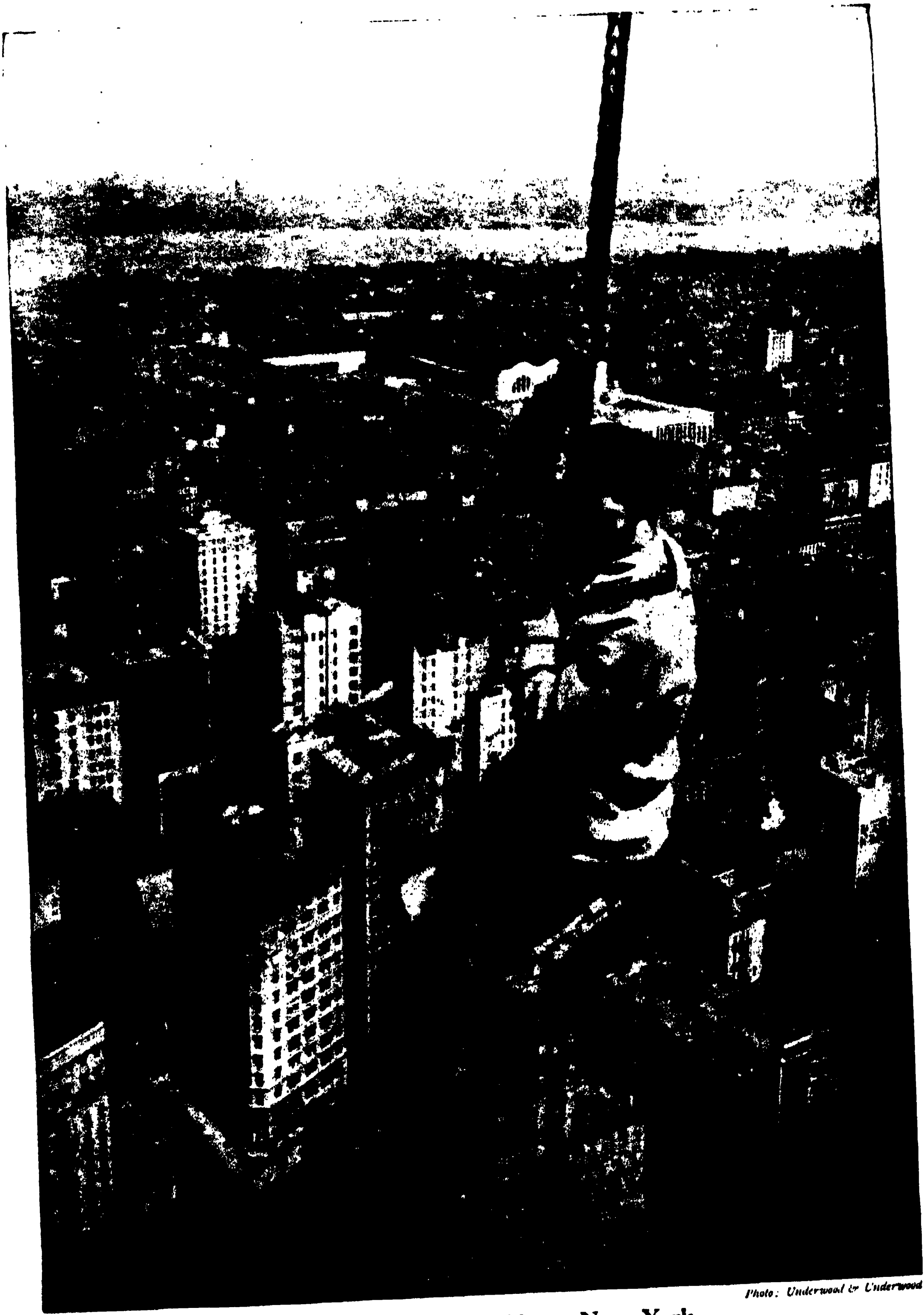


Photo: Underwood & Underwood

Five Hundred Feet Above New York

Up in the rarefied air, to which dust does not ascend, men of marvellous nerve fix bolts and ties on buildings fifty-five storeys high they have right to be. For their product is incomparably wonderful in appearance and result. They erect a city upon a plot of land which may be only a hundred feet or so in length, by twenty or thirty in width, at its narrowest point. Within the completed building are homes, businesses, churches, chapels, shops, offices, ballrooms, concert halls, restaurants, schools and academies. They have their own systems of lighting and heating, not one system of each, but several, one to a given number of floors. They have their organised scheme of transit as complete as that of a railway company, and carrying as many passengers. Thirty thousand people are engaged at one time in these buildings, and with their myriad callers they are carried up and down by from fifteen to a score of lifts; lifts which stop at every floor in turn, lifts which stop at only a few, express lifts which in a few seconds travel the entire distance from ground floor to turret.

30,000 People in One House

The swift and powerful lifts which America has perfected have made these skyscrapers possible; without them they would have been impossible. England gave her the germ of the idea for the steel-frame building and gave her also, in the Bessemer process, the cheap steel upon which they depend. For the rest the idea is American, American in originality and audacity, American in apparent blindness to, or at least cheerful acquiescence in, the fact that row upon row of skyscrapers are allowed to convert sunlit highways into gloomy, unlighted ravines. For it is that which the business thoroughfares are becoming. Flanked by skyscrapers a man walks at the foot of a range of precipices, and during great part of the day he must crane his neck and strain his eyes to catch a glimpse of sunlight.

But the end is not yet. The New York building laws allow the builder to reach any height at which he may aim, provided that he does not impose a greater weight than fifteen tons to the square foot upon the foundations. And with that allowance the man who put up the Singer building declares that he could build a skyscraper 2,000 feet high with 150 storeys. A rival architect has offered to run up a building of 1,500 feet for £6,000,000; Mr. O. F. Semsch, chief engineer for the Singer edifice, will put up his 2,000 feet structure for £12,000,000. For this sum he would have a building with walls about 12 feet thick at the bottom, and 12 inches thick at the top, the total load on the foundations, "live" and "dead," to be 516,000 tons, or two tons per square foot within the regulations of the New York building authority. Added to the difficulty of securing normal rigidity in so colossally high a structure, there is the matter of wind pressure to be met. This is countered in various ways by existing buildings which, in the squalls to which Manhattan Island is subject, have at times to withstand a pressure of winds far more violent than that which destroyed the Tay Bridge.

The Singer building, constructed after some of its predecessors had taken to alarming swayings in heavy winds, was secured by ties running from the turret down to the foundations, where it is bolted to an anchor plate of enormous strength fixed in the concrete bed. Mr. Semsch estimates that the side of his 2,000 feet building would be exposed to a wind pressure of 6,000 tons, the centre of pressure occurring at the 1,000 foot level. Opposed to this his plan of building would, he says, give a moment of stability of 51,600,000 foot-tons, hence he would be safe. The figures have been much discussed, but not impugned. Some day we may see the task attempted. After having outsoared the Washington monument by 200 feet, the Great Pyramid by 800 feet, and St. Peter's by 302 feet, American engineers will never rest content until they have out-Babelled Babel.

To Out-Babel Babel

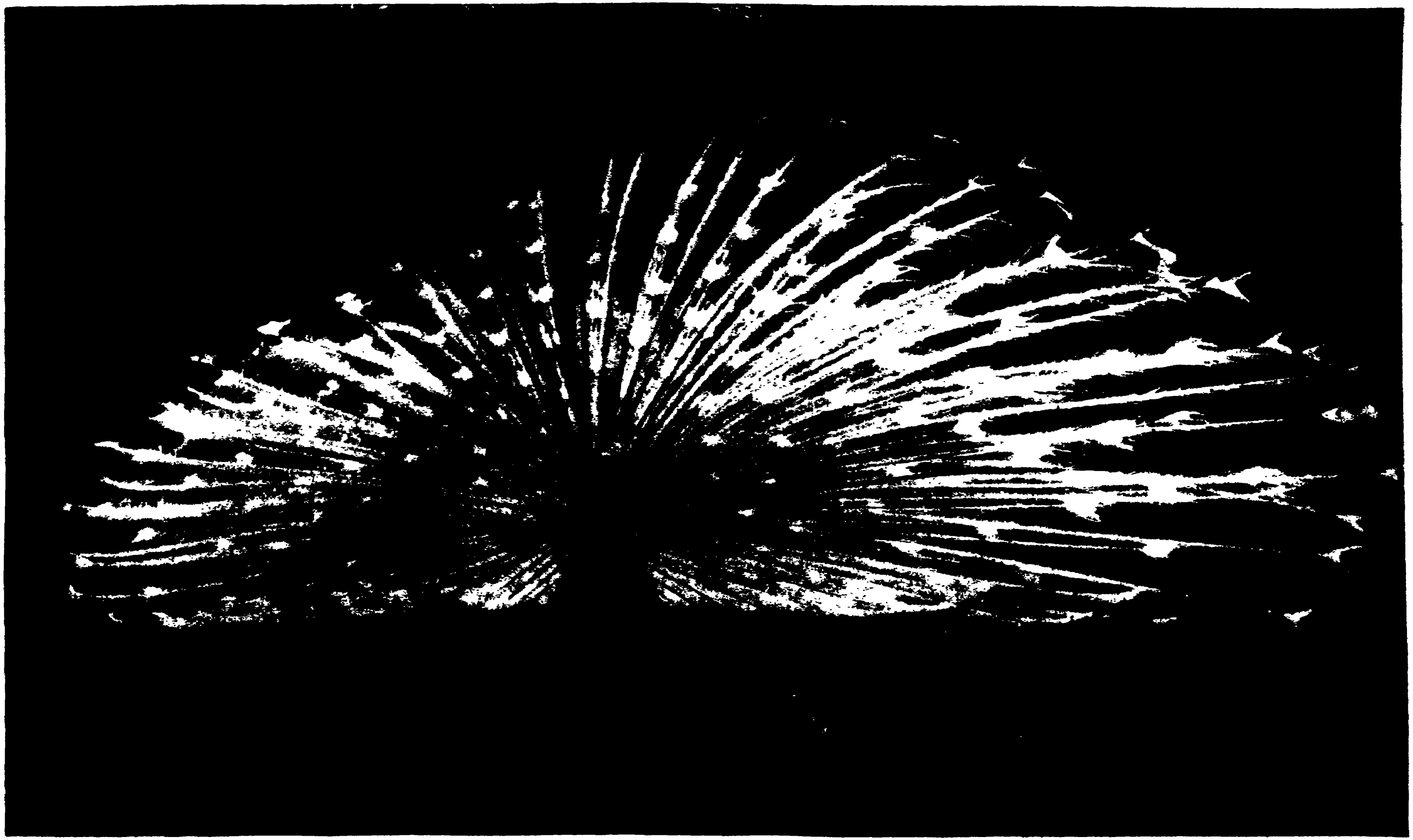
FINE PLUMAGE-I

By Sir H H.Johnston, G.C.M.G., K.C.B.

Long-eared Owls, with Nest

Which of the Birds is Most Beautiful ?
Some of the Larger Birds of Exquisite Plumage Discussed

IT is probable that the supreme, culminating forms of reptiles in the far past developed amazing colours on their scales or their bare skins, especially in the male. There are living in our own times a few lizards of gorgeous tints, decked out with cobalt-blue, scarlet, grass-green, orange and purple-black. Some snakes are lovely to look at with their carpet patterns of coral-red and black, of golden-yellow and brown with a mauve sheen, or the whole body one long whip of emerald tinged with turquoise-blue. Possibly some of the Pteranodons or giant Pterodactyls—the huge reptilian bats of the end of the Secondary epoch—may have had enamelled beaks of mother-of-pearl or vivid colour on their leathery bodies or the upper surface of their wings. Even in the lowlier class of amphibians there are beautiful tree-frogs of azure-blue, jade, or beryl-green; or marsh-frogs of orange and black, green and gold. But of all the land vertebrates no division has attained such an equal climax of beauty in form and colour as Birds. They are, indeed, a foreshadowing of the angel, and when man in his more primitive religious conceptions wished to picture to himself a heavenly being, he combined with the human form the wings and often the head of a bird. Moreover, compared with all other classes of animals (and man heralds now a new class which shall some day link the mammal with the god), birds are not only far and away the most beautiful, but they are the least inimical to human interests, come least of all into conflict with him either as creatures



The King of Birds

For size, colour, grace, fantastic adornments, pride, and alert intelligence the peacock must be adjudged the king of birds. The one shown here is one of the few white pea-fowl in captivity, imported by the Cincinnati Zoological Garden from the Carl Hagenbeck collection of rapine, spreaders of disease, or destroyers of crops. Consequently, if the retention and extension of beauty in this terrestrial world is to be one of the objects pursued by mankind in the future, we and our successors must take measures for the protection of birds from destruction at the hands of ignorant or wicked people. And we must do so not only from a love of beauty, but from the practical conviction that birds are our chief allies in the unending war which we have to wage against the lower forms of life, against the insects, molluscs, and worms, or the rodent mammals, which not only attack and devour many forms of vegetation supremely necessary to man's needs, but also act as the carriers of those minute animalcules or spores that are the origin of germ diseases, the diseases that destroy so much of plant, animal, and human life.

Yet we are slow to appreciate these facts, which indeed have only lately been made quite clear by the researches of science. The British Government still, throughout all our vast dominions, thinks the preservation of birds a matter of no moment and a fad only interesting to a few Nature lovers and painters. Meantime, the rough pioneers of the great white nations are everywhere making bird life scarcer, partly to sell birds' plumage for the decoration of women's costumes, partly to feed on the flesh of game birds, but as often as not from that sheer love of destroying beautiful or striking forms of life, which is, unhappily, a characteristic of man from the stage of undisciplined wonderment which began as far back as apehood, and which still distinguishes the schoolboy and the grown-up schoolboy of our own country.

Photo by Sir H. H. Johnston.

A Cock Ostrich

Running with his great white-plumed wings expanded, the cock ostrich is a splendid sight

Man, indeed, had scarcely attained the mental and physical level of humanity than he snatched at the plumage of the birds he caught for his food in order to decorate his hideous person. The males of the human genus began the practice, for the men have had the best of the good things of this world for something like a million years. It is the men amongst savage or uncivilised peoples at the present day that monopolise most bird decorations, sticking feathers into their hair or wearing the beaks of birds as terrifying crests. The negroes of Western Tanganyika make marvellous head-dresses three times the height of a guardsman's busby out of the red tail-feathers of the grey parrot. Most of us are familiar (through the British Museum) with the magnificent costumes made by the civilised and uncivilised aboriginal races of America out of birds' feathers. Several exquisite forms of bird life have been brought very near extinction in the Pacific islands since that region was colonised from 4,000 to 2,000 years ago by the semi-Caucasian Polynesians, who everywhere carried with them the white man's (often misdirected) love of beauty. Ostrich feathers were probably first worn as plumes by clothed and semi-civilised people in Syria, Persia and Mesopotamia, some 4,000 years ago, at a time, no doubt, when the ostrich was still found wild in those regions. As far as Europe is concerned, it is probable that the ostrich plume was first introduced by the Crusaders, but it did not become an article of fashionable wear in men's and women's hats until the seventeenth century.

Photo by Sir H. H. Johnston

A Wonderful Head-dress

Of immense size, made from the red tail feathers of grey parrots

Birds of paradise plumes as adornments first attracted the attention of the Malay invaders of the great archipelago which stretches from Sumatra to New Guinea; and in the course of trade they were conveyed to the kings and chiefs of Southern India, whence, as fashionable decorations for men, they spread to Persia and Turkey. But they were not worn by women until about a hundred years ago, when the turban as a form of head-dress began to make its appearance amongst fashionable women in Western Europe, and with it came the splendid plumes of the bird of paradise or the aigrette of the white heron. Indeed, if one looks back through pictures of women's dress in the past centuries, one cannot see much wearing of feathers (except the ostrich plume) until the beginning of the nineteenth century.

During the last hundred years this taste has increased, till it has led to an enormous destruction of bird life, and to the solid enrichment of many firms of traders in bird skins. It is time for stringent legislative action to stop or check their supply of material.

Remarkable amongst birds of beautiful plumage, though perhaps less known (and less persecuted) than many other bird wonders, is the Turaco family, the "plantain-eaters" of tropical and South Africa. The species which is illustrated in the colour plate is the violet Plantain-eater of Uganda (*Musophaga rossi*). This lovely creature is—or was a few years ago—very common about native villages and plantations in Uganda, and did not show much fear of man. On sunshiny days small companies of these birds would play about on the great boles of the fig-trees, varying their gambols by occasional attacks on the

From a photo in the possession of the Royal Anthropological Institute

A Zulu of Fifty Years Ago Preparing for Battle

It is the men amongst savage or uncivilised peoples that monopolise most bird decorations, sticking feathers into their hair

clusters of ripe figs. The prince of this family is the great blue plantain-eater of equatorial Africa, the size of a large pheasant, and somewhat like a pheasant in appearance, there being (unlike the other turacos) a considerable difference in size and plumage between male and female. In appearance, indeed, the great blue plantain-eater somewhat recalls the tree curassows or arboreal gallinaceous birds of tropical America.

Photo by W. S. Berridge, F.Z.S.

The Silver Pheasant

It is really only amongst the pheasants that we can match the brilliancy of colouring in the tree-frequenting birds

It is rare to meet with positive colours of extreme brilliance—purple, green, crimson, etc., away from the Picarian and Passerine birds, the Parrots and the Pigeons. About the only representatives of the more terrestrial or water-frequenting birds which have gorgeous plumage are the pheasants, and a very few amongst the ducks. It is really only amongst the pheasants that we can match the brilliancy of colouring in the tree-frequenting birds. The golden pheasant, clad in crimson, golden-yellow, dark blue, etc., is a familiar example. Some of the less-known species of jungle fowl have not only beautiful colours in their plumage but exhibit exquisite tints of rose and blue-green on the comb or wattles. A pheasant of very remarkable coloration is the *Lobiophasis bulweri* of Borneo, with an immense white tail, and the body plumage of maroon-crimson, black and blue, with cobalt-blue wattles and naked skin on the face. The huge Argus pheasant in grey, brown and creamy white, with its beautifully shaded ocelli (like huge pearls set forth on velvet), the allied form of Reinhardt's pheasant, with a tail five feet long, the

From a Painting by Sir H. H. Johnston

Violet Plantain Eaters

The Plantain Eaters (*Musophaga*) are a genus of the beautiful Turaco family only found in the Equatorial forest belt of Africa, from Uganda on the east to the Gold Coast on the west. They are not usually shy of man, but play about on the branches and boles of the trees round the native villages and plantations, uttering squawking and mewing cries like parrots

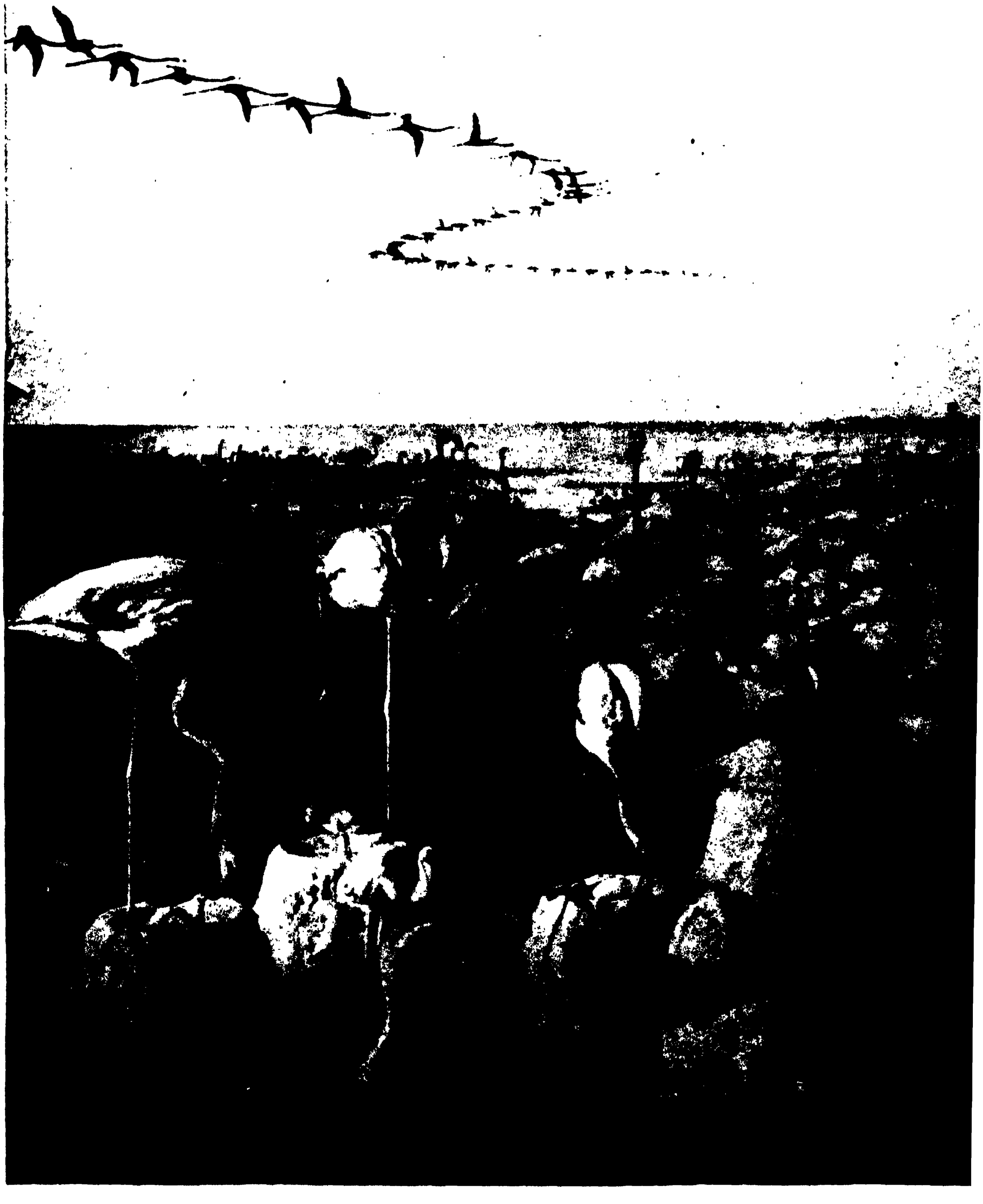
wonderful peacock-pheasants with their iridescent, jewelled tails, are other striking examples of birds of fine plumage; while, of course, the crown of the whole of this magnificent order of the *Gallinaceæ* (which includes the enamelled blue, green, purple, and copper Honduras turkey, a number of handsome curassows, and the noble grey and black-green Capercailzie grouse) is the peacock of two species, one with a neck of intense ultramarine-blue, and the other bronze and golden-green, with bare blue and yellow cheeks. For size, colour, grace, fantastic adornments, pride, and alert intelligence, the peacock is adjudged the king of birds.

Brilliant colours appear in a few species of duck, but a true-red, green, or positive blue are entirely absent from the scheme of colour in Anserine birds (except as regards beak or bare skin), though some of the ducks exhibit beautiful iridescent tints in head or wing feathers. The Mandarin duck of China has actual purple on the breast in the male breeding-season plumage. There are patches of delicate grass-green on the cheeks of the little pygmy geese of Africa, and amongst the true geese is the handsome Emperor goose of the northern Pacific coasts, but in this bird the beauty arises from the vividly contrasted black, white, chestnut, cream, and grey, rather than from the presence of any specially lovely colour. In the near allies of the ducks and geese—the flamingoes—the plumage (as in the case of many water-frequenting birds—gulls,

Photo lent to Sir H. H. Johnston by the New York Zoological Society

The Harpy Eagle

All the eagles are handsome to the eye, the climax being reached in the magnificent Harpy eagle of America



A COLONY OF FLAMING

n the near allies of the ducks and geese—the flamingoes—the plumage assumes a rosy tint, dee virtually becomes

From a reconstruction in the American Museum of Natural History, New York

IN THE BAHAMAS

into scarlet-crimson on the wings. In the commonest species of American flamingo this rosy tint all over the body

ibises, pelicans, phaethons, and storks) assumes a rosy tint, deepening into vivid scarlet-crimson on the wings. In the commonest species of American flamingo this rosy tint virtually becomes scarlet all over the body. In America likewise are to be found the equally vivid scarlet ibis and the delicately beautiful roseate spoonbill.

Condors, the Largest of the Vultures

The birds of prey are not noted for bright colours, but the Condor of the Andes is a magnificent bird. In large individuals its expanse of wing is said to reach eight or nine feet

The crested ibis of Madagascar is a beautifully coloured bird with a plumage of mauve-tinted chestnut, snowy-white, iridescent blackish-green, and cream-yellow, with coral-red legs and a bright green beak. The Hagedash ibis of Africa is as splendid in its iridescent blue, green, and copper as the Monal pheasant of the Himalayas. Equally striking, however, in another way is the sacred ibis—snowy-white, with inky-black plumes and naked skin. Swans, of course, are appreciated more for their exquisite shape—seen at its finest development in the mute swan—than for colour or absence of colour. Yet the snowy-white of the northern swans is a beautiful feature in landscapes. Very striking also is the black-necked swan of South America, nearly as large and as handsome in outline as the northern swans, snow-white, with a jet-black neck and red beak. The black swan of Australia is not really black, but inky-grey with a coral-red beak.

The birds of prey are not noted for bright colours, though vultures are admirable when sailing on their pinions through the air. Equally handsome to the eye are all the eagles, the climax of which is the magnificent Harpy eagle of America.

I.—On the Land : Natural

INSECTS' EGGS

By Harold Bastin

Photo by H Bastin

Empty Egg-shells of the Eyed Hawk Moth (much magnified)

Miracles of Packing
Female Bricklayers and Cement Makers of the Insect World

INSECTS' eggs are extremely diverse in form. Many are exceedingly beautiful objects, while not a few approach the fantastic in the strangeness of their shape. As regards size, it is a mistake to suppose that they are excessively minute. Most of them can be distinguished by the unaided eye, though for an effective examination a microscope is often indispensable. In many instances, however, an ordinary pocket lens supplies all the magnification that is necessary, and it is with eggs of this grade that I propose chiefly to deal.

The shell of an insect's egg is not calcareous, like a bird's, but consists of a tough, horny substance which is very durable, being capable of resisting fairly strong acids. It may be glassy or opaque, smooth or exquisitely sculptured ; but the appearance of the egg-shell is so characteristic in each species that an expert naturalist can usually predict, at a glance, the particular kind of insect that will ultimately be hatched from it. He judges chiefly by the size, shape and adornment, and perhaps, to some extent, by the manner in which the different kinds of eggs have been laid.

Almost every insect has its exclusive method of egg-laying, just as every bird builds its nest in a particular way. For instance, the female Lackey moth deposits her eggs in the form of a bracelet on a suitable twig—working her way round and round, in a methodical manner, until her maternal capabilities are exhausted. The beautiful canary-shouldered Thorn moth lays rectangular eggs (nobody knows why !) and places them systematically in a long row, exactly like the first course of bricks in the foundation of a wall. But, generally speaking, the eggs of scale-winged insects (i.e. butterflies and moths) are spherical in shape, and are fixed—either singly or in clutches—to a shoot or leaf of the appropriate plant.

When the egg is laid, it is usually accompanied by a minute drop of adhesive fluid which hardens rapidly upon exposure to the air. In this way the egg is held securely in its appointed position. Among lacewing " flies " and their allies, this natural cement

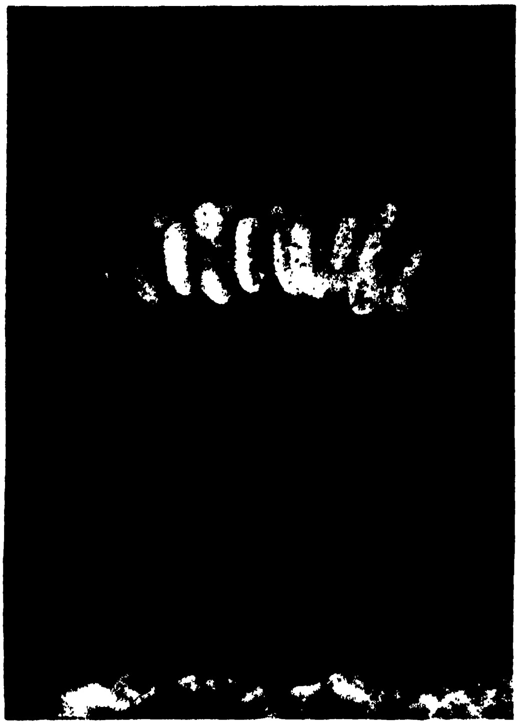


Photo by H. Bastin

Stalked Eggs of the Lacewing Fly

The parent insect elevates each egg above the ground on a stiff thread of cement

Photo by H. Bastin

Capsules of Praying Insects

Mantids construct elaborate egg-capsules and affix them to twigs

serves a strange purpose, being drawn out by the parent insect to form a stiff thread, or stalk, at one end of which the egg is supported. These eggs are often dotted about a leaf or twig—one here, another there. Sometimes, however, they are laid in groups, twenty or more in close proximity. In either case the effect is curious, to say the least of it.

Men of science have racked their brains to find a plausible theory to account for these stalked eggs. One notion is that they are thus raised above mundane things in order that they may be saved from the attacks of egg-eaters and egg-parasites. It has also been suggested that the newly hatched lacewing larvæ cannot be trusted. They are ferocious little beggars, and it is thought that they would set to and eat one another if they made their début in the ordinary way on *terra firma*, or, perhaps, one ought to say on *planta firma*; but after each has climbed, like Jack, down a kind of beanstalk, their ardour cools, and they disperse quietly in search of their proper prey. This prey, by the way, consists of aphides or "greenfly," and there can be no question that lacewings benefit mankind by checking the increase of these well-known pests. Touching the manner in which the eggs are laid, however, it is perhaps best to admit frankly that no really satisfactory explanation has yet been offered.

Fortunately, science has no blushes. Otherwise, one might hesitate to mention some of the most striking of all insects' eggs, because they happen to be laid by certain little parasites (known popularly as "bird lice" or "biting lice"), which live among the feathers of birds and the hairs of a few kinds of mammals. Each kind of "host" creature has its own parasite, and each kind of parasite lays eggs

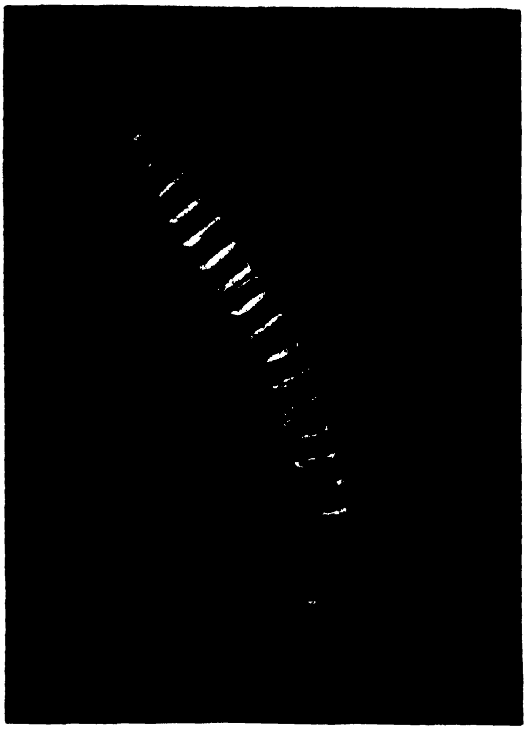


Photo by H. Bastin

A Puzzle to Scientists

Nobody knows why the canary-shouldered Thorn moth places her eggs like a row of bricks

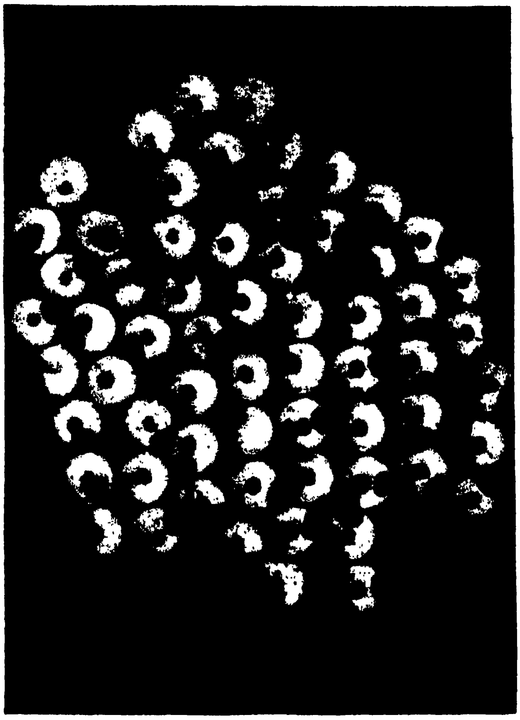


Photo by H. Bastin

Hatched Out

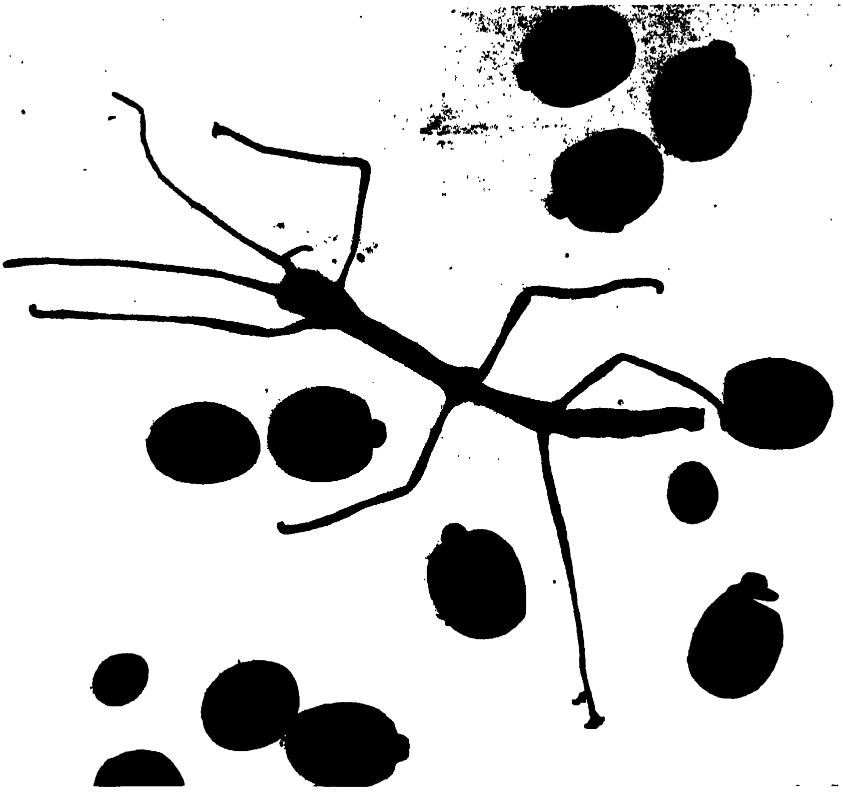
Observe the holes in the sides of each egg by which the larvæ of the Buff-tip moth have escaped

of a characteristic form, fixing them to the feathers or hairs as the case may be.

The manner in which a young insect escapes from the egg is interesting. In certain instances it gnaws its way out through the side of the shell; or it may split the whole shell by contortions of its body.

Quite often the newly-hatched larva carefully eats up its egg-shell before turning to more inviting food—though this is by no means always the case. The eggs of "walking-stick" insects and their relatives are very much like seeds in appearance. Each is furnished with a kind of lid, which is pushed off by the inmate at the time of hatching. It should be mentioned that experts regard these eggs as compound structures. The seed-like external part, including the lid, is not properly the egg-shell, but a kind of pod or capsule within which the egg and its shell are contained. This plan of packing the eggs into a stout protective envelope is carried to great lengths by some other insects, including the familiar cockroach—often called the "black-beetle." The female cockroach deposits her eggs in batches of sixteen at a time, each batch being packed in a mahogany-coloured receptacle, eight eggs on each side, in two parallel rows. This valuable package is carried about by the mother, attached to the end of her body, until a safe hiding-place is discovered.

"Praying insects," or mantids, construct egg-capsules, which are even more elaborate, and fix them to some stationary object, such as a stone or a twig. Briefly, the eggs are laid several together in flask-shaped receptacles, and these are arranged one against the other in two overlapping rows, the whole series being enveloped in a glutinous secretion which solidifies to form the capsule. Along the ridge of the latter may be seen a double row of small holes or slits. These are the openings of the egg-flasks, through which the young mantids effect their escape after hatching. Mantids' egg-capsules are often quite bulky objects, 2 inches or more in length, and each may shelter from 200 to 800 eggs.



A Miracle of Packing

A newly hatched "Stick" insect. This insect has not fed since pushing off the "lid" and emerging from its shell, to which it is still attached by the claws of one leg

The power of resistance possessed by insects' eggs is very remarkable, especially in relation to extreme cold. Many kinds may be frozen into a block of ice without detriment to their vitality. But the most wonderful thing about the egg is its contents. At the appointed season the shell breaks open and discloses a marvellous being, fully equipped for the battle of life, and destined, by fortune's favour, to reproduce all the attributes of its parents. For we must not forget that the entire potentiality of the perfect insect—its form, colour, capacities and habits—are bound up in this tiny package, which we call the egg. How this miracle of packing is accomplished is a mystery; but the fact remains that, from the moment of hatching, the little stranger begins to grow and expand. A baby "walking-stick" insect appears to be many sizes too large for the egg-shell from which it has just escaped, even before it has taken its first mouthful of food.

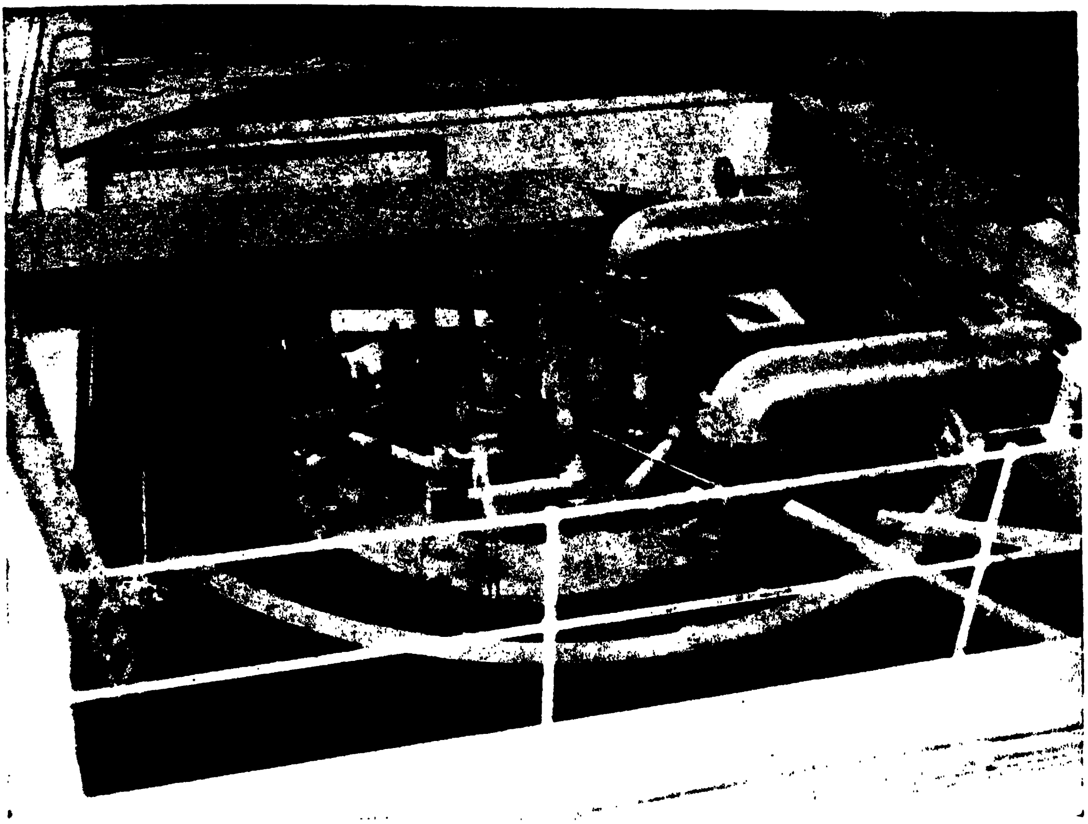


Photo Illustrations Bureau

Humphreys Pump at Chingford

Kicking a River Upstairs

How the Lea is Lifted to Thirsty London

By ERNEST BLIGH

ALFRED the Great set the seal upon his reputation as a military engineer, when, the Danes having driven their war galleons twenty miles up the Lea, he prevented their return by diverting the river from its bed and running it into shallow, artificial channels. It has remained for the engineers of the twentieth century to eclipse his feat. The old established New Cut, which ran the River Thames into the Limehouse and Blackwall Docks, was but a variant of the Saxon monarch's achievement. To-day, instead of damming the river, we lift it bodily into the air, and, with its waters, store one of the largest reservoirs in the world. The performance, unique in the annals of engineering, is due entirely to an example of mechanical wizardry—the Humphreys pump.

The position explains the need for the invention. Through Bedfordshire and Hertfordshire and into Essex flows the Lea, and at Chingford we construct a mighty reservoir of 460 acres, or more than Hyde Park in area, with a capacity of 3,000,000,000 gallons. In normal times, the Lea is a modest little river, but in periods of flood

Photo: Illustrations Bureau

Water Being Pumped into Chingford Reservoir

There are five of these pumps. Four of them can each kick upstairs 40,000,000 gallons of water a day; the fifth can raise 20,000,000 gallons in the same time it is a raging torrent, hurrying away its precious waters to the Thames too rapidly for any ordinary methods to detain them. How were these invaluable floods to be captured? The Humphreys pump is the answer. It is the simplest invention in the world, yet the most marvellously effective. Imagine a motor-car engine and substitute water for piston, and you have the Humphreys pump.

The Motor Engine

In the motor engine petrol gas is admitted into the cylinder, and, just as the piston has completed its upstroke, so compressing the gas, a current of electricity causes a spark within the cylinder. The gas is instantly exploded, and expands enormously. In so doing, it kicks down the piston, whose force is transmitted, by way of the connecting-rod, to the crank-shaft, thence through the fly-wheel and gear-box to the road-wheels. Your car may have one cylinder, or it may have four or six, but the process is the same in all. All the cylinders are coupled, of course, to the same crank-shaft, and each explosion of gas in a cylinder, kicking down a piston, gives you the power that carries you over the road at whatsoever pace you will.

Now, in the Humphreys pump, we have simply the cylinder, the gas and the spark, but no piston. Water from the river enters the bottom of the cylinder by rhythmical intakes. When the cylinder contains the due amount of fluid, coal-gas is admitted through a valve in the head of the chamber, an electric spark flashes from a sparking-plug on the opposite side of the cylinder-head, there is a hoarse, barking explosion, and instead of a piston, the water itself is kicked down. It is kicked down the cylinder, through a narrowish outlet at the bottom, and up a water tower 30 feet in height, built parallel to the cylinder. At the top of this tower there is an outlet admitting the water into the reservoir. Every explosion within the cylinder kicks twelve tons of Lea water upstairs, by way of the ascending tower, out into the colossal reservoir.

There are five of these pumps. Four of them can each kick upstairs 40,000,000 gallons a day; the fifth, the little Benjamin of the group, can raise his 20,000,000 gallons in the same time. All are controlled by an electric circuit simple as the principle by which we light just as many electric bulbs in a room as we want. At a moment's notice the whole five can be set to work, or four, or three, or two, or one. They can be stopped as quickly as they are started. When all are at work, they can, in the course of a day, lift 180,000,000 gallons out of the river into the reservoir. The whole plant will be needed only when the river is rushing its flood waters onward to the Thames.

A Terrific Challenge

There is quite a romance in the story of the installation of these pumps. Mr. H. A. Humphreys, a London consulting engineer, became possessed of the brilliant idea of converting the internal combustion engine into a pump. He tested models, and, finally, got a 30 horse-power engine to work. Just at that time the London Water Board, beginning their mighty Chingford reservoir, cried to the world for something new in pumps. Mr. Humphreys mentioned his, and after some deliberation, the Water Board agreed to take his invention—on terms. Each pump must develop from 200 to 300 horse-power, on penalty of £20,000 and, the whole installation must not consume more than 1·1 lb. of coal per horse-power per hour. If the invention proved unsuccessful, he must forfeit £20,000; if the rate of coal consumption exceeded the limit mentioned, he must forfeit £1,000 for every tenth of a pound of coal in excess of the stipulated maximum. It was a terrific challenge, but Mr. Humphreys accepted it, gained the verdict, and at a bound attained world-wide fame and the prospect of a colossal fortune.

It is a wonderful pump that he has

contrived, yet it is marvellous, now we know it, that no one thought of it before. It simply makes gas do that which steam, when first harnessed, was set to accomplish. Papin and Savery, the first men in the modern world to employ steam for an engine, actually brought steam into contact with the water which had to be raised, just as Mr. Humphreys brings the gas for explosion to the head of each 12 tons of water that has to be kicked upstairs.

The Proteus or Olm

A Dweller in the Gloomy Caves of Carniola, which is Normally Born Blind

By W. S. BERRIDGE, F.Z.S.

To mention a living creature as being normally blind seems to suggest an absurdity, but nevertheless such an animal does exist, which is not only without eyes, but also lives entirely in the dark. It is known as the Proteus or Olm, and belongs to the Salamander tribe; it has the curious characteristic of retaining its gills throughout life.

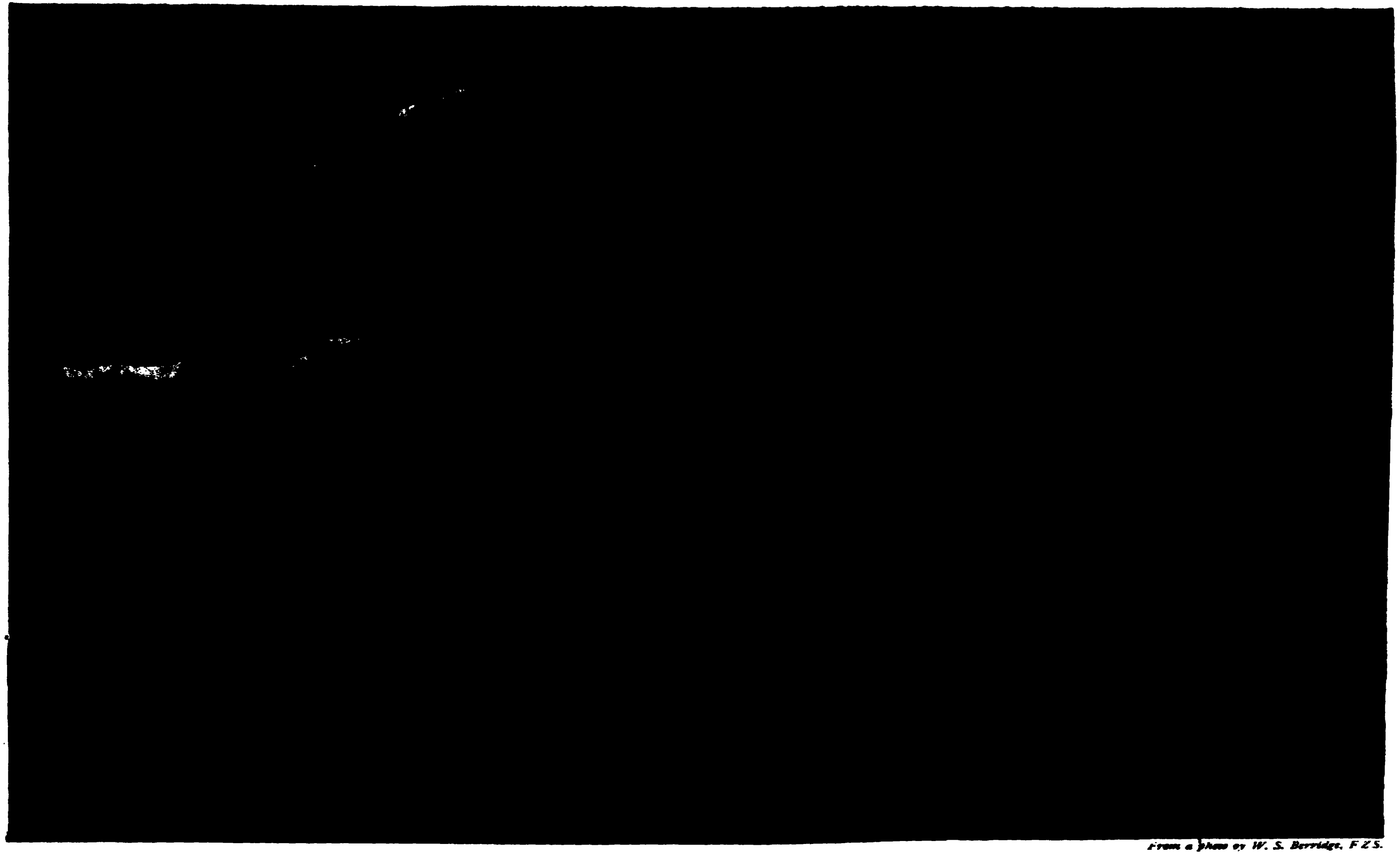
The home of these animals is in the underground waters of the caves of the Alps, in the districts of Carniola, Dalmatia, and Carinthia. Owing to the inaccessibility of their habitat, it is only during times of flood, and the consequent rising of the waters, that their capture is rendered possible.

The Proteus is of a snake-like build, and an adult specimen will attain to a length of about ten inches. Although, doubtless, at one time the ancestors of these creatures were possessed of normal eyes, the only vestiges of these organs now remaining are two minute dark specks, one on either side of the head. The fore and hind limbs are also rudimentary, and the digits so small and weak as to be entirely without the power of grasping.

In colour the Proteus is almost white, with the exception of the gills, which are bright red; but it is interesting to note that captive specimens that have been induced to live under the influence of a brighter light than they are normally accustomed to, change to a brownish tint. They are extremely sluggish in disposition, and were it not for the scientific interest attached to them, would not prove very interesting inmates of an aquarium, for they select the darkest corner of their tank, and remain there motionless for hours; possibly their sedate habits add to their longevity—they have been known to live for as long as eight years in captivity.

The food of the Proteus consists principally of worms and the minute animal life usually found amidst water-plants.

The first young ones that were ever hatched in captivity were recorded in the year 1886, when a single female laid over seventy-six eggs, which successfully hatched out into tadpoles after a duration of three months. Although the young were of very similar appearance to the adults, yet their rudimentary eyes proved to be larger than those of the parents, and, furthermore, somewhat sensitive to light. This latter feature is of special interest in its bearing upon the supposition that the ancestral Proteus was a normally visioned creature, for it is in the young of animals that the ancestral characters are so often displayed, only to be lost, however, when maturity is reached.



From a photo by W. S. Berridge, F.Z.S.

The Proteus or Olm

In colour the Proteus is almost white, with the exception of the gills, which are bright red. It is of snake-like build, and its limbs are rudimentary

The Horror of the Burning Mount

(Drawn by Professor Ricardo Pellegrini, during the Eruption of 1906)

A few years ago the fate of Pompeii was reproduced in miniature, when the village of Ottaino was buried in ashes and many of the inhabitants were immured amidst the ruins of their homes

II.—In the Underworld: Artificial

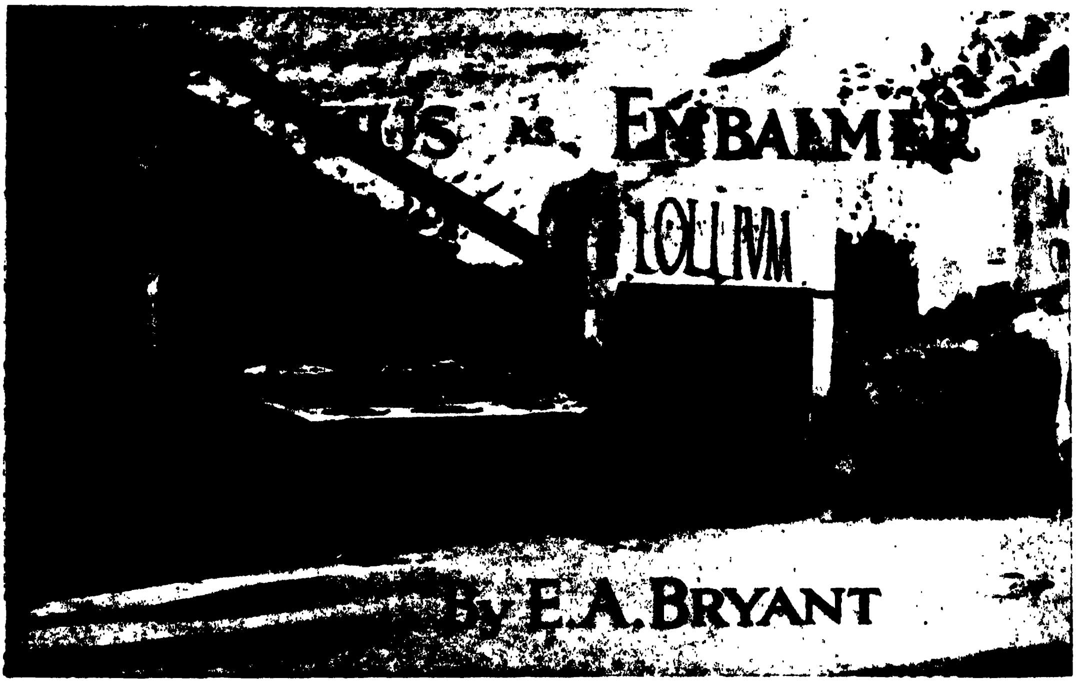


Photo: C. Abeniacar

Election Notices of the Year 79 A.D.

The Buried City of Pompeii
Removing a Death Mask Eighteen Centuries Old

PICK and shovel are writing to-day a story over eighteen centuries old, the story of one of the greatest tragedies in the world. Little by little, palace by palace, mart by mart, corpse by corpse, the ancient city of Pompeii is adding chapter to chapter of her autobiography of anguish. Skilled excavators are releasing her from the burden under which with her dead she lies buried, beneath the vomit of a burning mountain, which in a twinkling converted her from the gayest, most licentious city in the world into one vast catacomb. The origin of the work is not new. The present generation has grown up in the knowledge of the digging down to Pompeii, but of recent months discoveries have been made which have eclipsed all previous finds, and reveal dread Vesuvius as the master embalmer of the world. Vesuvius buried the city and its people, but first she wrapped the inhabitants in such a winding-sheet that every detail of their outline is preserved, the very expression of agony they wore as they parted with their breath. The hound with his massive silver collar lies, distorted, with jaws wide agape, in the last death agony; the climber still grips the bough of the tree he climbed; children still clasp each other heart to heart; slaves and owner lie welded together in a common matrix of lava; the beautiful patrician wears the jewels for the rescue of which she tarried before fleeing—to death. But these are not the greatest, the most incredible of the new wonders.

Pompeii, which became a sort of Rome-on-Sea, was founded when Zedekiah ruled in Jerusalem, when Nebuchadnezzar was king of Babylon, six centuries before the Christian era. Rome itself was then only a straggling collection of tribal settlements, established, a century and a half earlier, by pioneers, who found fish abundant in the marshes, and life tolerable upon her seven hills. When Pompeii sank to ruin beneath her pall of incandescent lava she was a city of 800,000 souls; Rome was mistress of the world, and had for six-score years been settled in Britain. The city was built at the southern base of Mount Vesuvius, fourteen miles south-east of Naples, and became a vast treasure-house of art and luxury, the seaside resort of the wealthy patricians of Rome. The arts of painter, sculptor, carver, and men skilled in the use of precious metals were lavished upon the city, and we may yet find art treasures inestimable from the parts that remain buried. The last known copies, made from the originals, of the pictures of Apelles, the only man whom Alexander the Great would allow to paint his portrait, were at Pompeii. What if one last surviving original should be found !

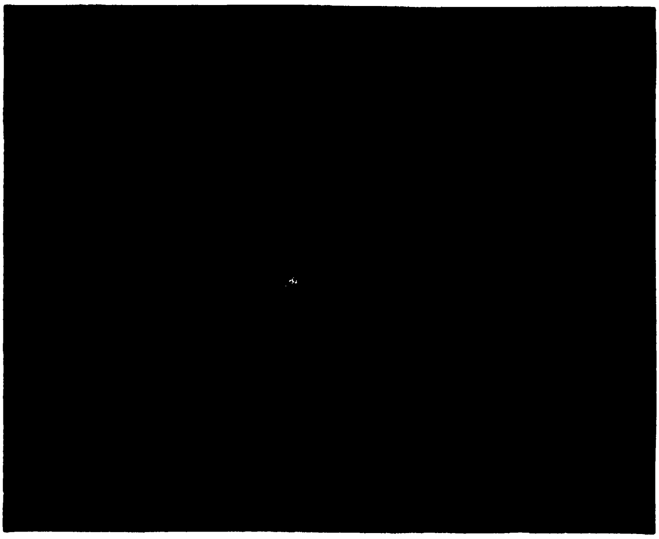


Photo: C. Abeniacar

A Naked Athlete

1,834 years ago this man sought to save himself by climbing a tree. To-day his petrified limbs still cling to a branch of stone

But with all her glories and riches and wickedness, Pompeii in A.D. 79 shared the fate of the Cities of the Plain. Vesuvius, at whose foot she had been challengingly placed, was seen suddenly to throw up a mighty sable cloud. The cloud was followed by a storm of burning dust, and the dust by boiling lava and an overwhelming torrent of red-hot stones. Over an area of fifty miles the sky was blotted out, and Pliny the younger, sheltering with his mother twenty miles away, was so laden with hot dust that he had repeatedly to rise and beat his garments lest the dust should bury him.

The eruption was accompanied by torrential rains, by earthquakes and tidal waves, so that those who fled from the city to the sea found no escape, and those at sea who sought the land were left stranded upon the heaving shore from which the waters had receded. Within the city itself death claimed for its own all who could not flee, and pouring molten lava converted them into statues. For three days and three nights the blazing volcano flung its fiery hail upon the city, burying every living thing, every building and monument. For fifteen hundred years Pompeii was blotted, not only out of existence, but out of knowledge. Peasants ploughed over the thin soil that collected upon the mountain of ash and lava that concealed the forgotten city. The sudden emergence in 1709 of Herculaneum, the sister city, five miles east of Naples, which with Stabiæ and Pompeii, was buried in the same fatal hours, led the world to remember that there had been a Pompeii. Then, casually and at intervals, vandal hands groped in the bowels of the buried town. Not until a recent year was the work organised. We are now reaping the fruit of that systematised search, and the harvest is rich, though poignant.

Many of the noble thoroughfares, with their amphitheatres, their forums, their palaces and cafés, are exposed. We see the

Photo by Mr. J. A. Scott copyright, Turner and Drinkwater

Vesuvius, as Seen From the Forum at Pompeii

This remarkable photograph taken at the time of the eruption of Vesuvius in 1906 (the worst for 100 years), gives an excellent idea of the art treasures that delighted them; the manner in which they conducted their households and business. But not until the other month had we so full and startling a revelation as awaited the diggers in the great "Street of Abundance." There they have brought to light a Roman public saloon bar, which needs but a barmaid for the immediate resumption of business, where it was suspended eighteen and a quarter centuries ago. Upon its walls of stucco are notices of the elections that stirred the public mind of Pompeii in the year 79. Upon one of the walls remain fresh and vivid the inscriptions favouring this candidature or that. One of these, translated, reads: "Asellinas and Smyrine say, 'Vote for Fuscus as your alderman.'" Hard by is the "bar," with its white-tiled counter, on which stands the barman's till, a small square box of bone, containing the very coins he had taken—coins of gold and silver, and counters of ivory, placed there in payment by the last customers ever known in that wineshop of the living Pompeii. But, more marvellous still, the very wine of which the customers of the house partook is in the jars of bronze, glass and terra-cotta in use on the fatal night. A cauldron, hermetically sealed, with the embers of the last fire beneath it, contains the water that was boiling for hot drinks and other purposes when disaster came 1,834 years ago. The entire premises were sealed over; the liquids in their air-tight vessels could not evaporate, and there they are to-day, to tell what the giddy youth of Pompeii drank while death was brewing for them in the colossal crucible frowning down upon the doomed city.

Photo: A. d'Agostino

The Street of Abundance

Recent excavations have revealed beautiful mural paintings upon the walls of the "Park Lane" of Pompeii

Relics more tragic and terrible have come to light on the threshold of a not distant palace. This was the palace of Obellius Firmus, a noble building. At the gates lie six figures, imperishably preserved in a matrix of lava. There lie Obellius himself and his wife, just where they were struck down by the fiery visitation. The mother and father have crept close together at the approach of death, to meet their doom hand in hand. Beside them lie their two children, clasped in each other's arms. Behind these four are those of two other persons, confidential slaves, it is thought, slaves ennobled and emancipated by their last act of fidelity. There they all lie, where they have lain eighteen centuries, perfectly embalmed by the art of the volcano; and there they will lie, for they are not to be moved, but to remain, a mute, frightful memorial of the death that came on molten wings. Near here they have found the naked athlete, who, seeking to avoid the blazing torrent of lava in the streets, sought sanctuary in a tree. The bough, perished by the heat, broke in his grasp and he fell with it, and holds it still with hands and knees, to tell the story of his vain endeavour to escape the hideous inevitable.

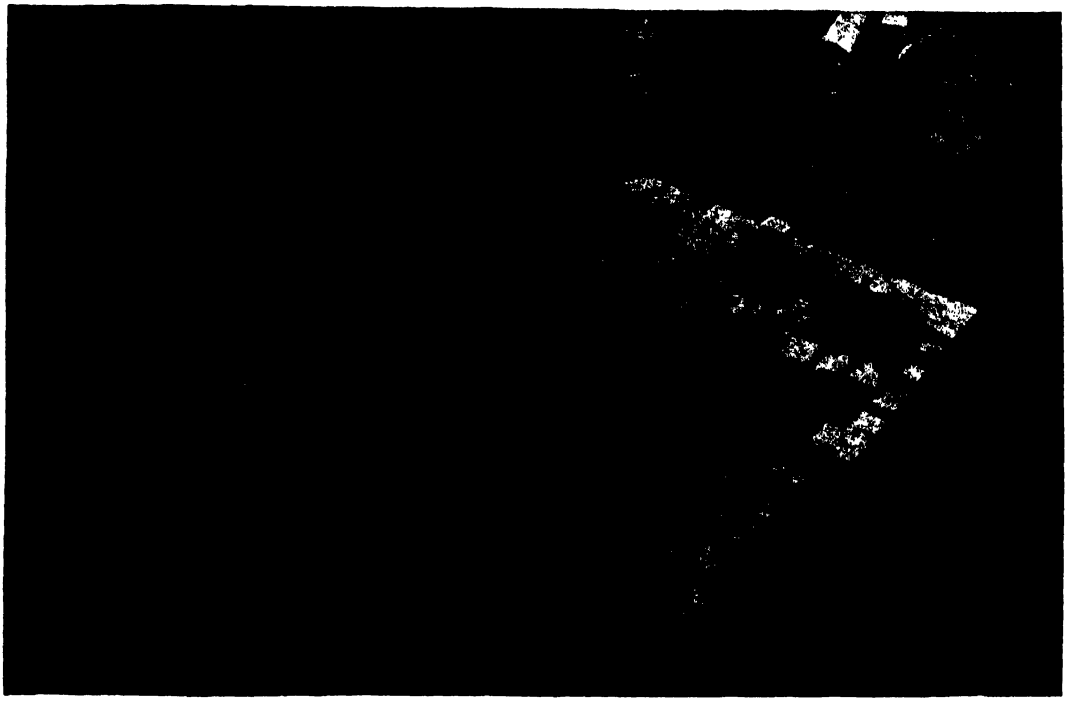


Photo: C. Abeniacar

The White-tiled "Bar" in a Roman Wineshop

After nearly 2,000 years the wine which the giddy youth of Pompeii loved to drink still stands in the vessels which Vesuvius hermetically sealed

And, again, within hail is found one of the patrician beauties of the city. Her beauty is gone, but her fair form remains, wonderfully outlined. And her spirit, if it revisits its ancient haunts, must find solace in the fact that she still wears her jewels, the jewels which she went back to seek and so bought with her life. The petrified Venus wears them all still—bracelets, necklaces, chatelaines. Among the jewels are two clusters, each containing twenty-one pearls of high intrinsic and archæological value. Herculaneum, which lies deeper, from 40 ft. to 100 ft. deep in the ash and lava, with two villages overspreading the surface, has yielded us priceless sculptures—the statues of Æschines, Agrippina, the Sleeping Faun, the Six Actresses, Mercury, the group of the Satyr and the Goat, the busts of Plato, Scipius Africanus, Augustus, Demosthenes, and Seneca, among others, but nothing so appealingly, poignantly human as these new relics of the last days of Pompeii. These late discoveries have kindled anew the ardour of the excavators, and every day some fresh appeal to the imagination comes to light. The buried city is almost the biggest prize-packet in the world to-day, and no one can say what treasure of art or history may yet be found as the work progresses, and the fatal winding-sheet woven by Vesuvius is withdrawn.

A Coral Reef at Samoa, in the South Seas

Such reefs begin with the labour of a soft, gelatinous, anemone-like animal, and end in reefs like mountain ranges, and islands fair as poets' dreams, crowned with palms and tropical verdure

III.—On the Sea: Natural

Coral Islands

The Story of Their Builders—Coral Polyps—the First of Architects

By N. F. WATSON

IF it be more laudable, as Swift held, to make two blades of grass grow where only one grew before than to win the highest success in statecraft, what prize shall be allotted the one who makes the ground on which the two blades grow ?

The coral polyp hardly comes into the scheme of human awards, so we can but think our acknowledgments. In the realms of Madrepore they require but simple favours, and such as are beyond the wit of man to bestow—clear sea-water and sunshine. The rest of the story lies with them. It is told in terms of homes for man created on the deep. It begins with the labour of a soft, gelatinous, anemone-like animal, and ends in reefs like mountain ranges and islands fair as poets' dreams, crowned with palms and tropical verdure, gemmed with birds of every hue, washed by azure seas, in which sport the strangest of all fish whose story is recorded in the amazing chapters of adaptation to environment.

We marvel at the precision and exactitude with which the bee fashions her cell of wax, but these soft-bodied zoophytes make their cells of adamant, fetter the turbulent ocean with rocky fortresses built for all time, cast up their ramparts in the sea to shatter the mightiest sea-going giant formed by man's hands, or, in the alternative, guard his shores with a breakwater unmatched for perfection of workmanship and durability.

The coral polyp, one of the master-builders of the world, may be likened to a sea-anemone, inferior in muscular organism, but immeasurably superior in defensive organisation. Its scheme of life was perfected far back in geological time. It became a family divided into many branches, each of which has developed along well-defined lines, but all distinguished by one

Photo by courtesy of "The Scientific American"

Coral-eating Chætodons

This realistic picture of a coral grove and its denizens was drawn by the under-water artist, Mr. Z. H. Pritchard

common wonder—the secretion of a lime deposit. In some this deposit becomes a coat of calcareous armour for the individual, in others there has grown up a communal grouping of animals sharing and building the same flower-resembling mineral city; in the most famous family of all, the limy deposit has been used to raise one titan aggregation of homes, all united and communicating, raised, stratum upon stratum, vertically and laterally, until reefs, atolls and islands result.

Every atom of coral in the world is simply the skeletal covering of what once was an animal which hated and hungered, loved and wooed, laboured and perished.

Photo by courtesy of "The Scientific American"

Coral Formations in the South Seas

This sketch, made under water by Mr. Z H. Pritchard, exhibits the stony monuments of innumerable lithotypes of bygone ages, which by slow degrees have grown tall enough to raise their summits above the water

It took more than one generation and much acrimonious controversy to convince the great ones of the learned earth that this is so. That which we now know to be the coral polyp they declared to be a true sea flower. The theory was "proved" by one of the greatest of French savants, who, securing a portion of coral, immersed it in a bowl of sea-water, and saw the bud-like protuberances, with which its surface was covered, open into what he took to be eight-petalled flowers, formed of elegant white and star-shaped corollas, outlined upon the reddish bark of the stems. The joyful note in which he communicated his supposed discovery to the French Academy of Sciences is still preserved, to correct the hasty judgments of the half-informed. "I send you some branches of coral, covered with white flowers," he wrote. "This discovery has made me pass for almost a sorcerer in the country; no person, not even the fishermen, having seen anything similar." The savants of Europe were convinced, and the unfortunate lithotypes lost their identity; they became officially and scientifically "flowers," although in the seclusion of coralline private life they kept up the pretence of being animals.

Photo, Underwood & Underwood

A Coral Quarry in Bermuda

Æon upon æon must have passed since the little flower-like animals perished whose skeletal coverings, now raised high above the water, provide the material for the building of men's homes

The fact that the "flowers" were hard as rock was accounted for by a fisherman's tale. The flowers, it was declared, were as soft as other vegetable organisations so long as they remained beneath the water, but hardened at once upon contact with the air. To this day Italian coral fishers hold the belief that corals are by nature soft, but petrify into stone from fright when touched by the net. This matches the inconsequence of that gardener on a large estate, who, when asked why there were no mushrooms, gravely replied: "Well, they were doing very nicely till a great rat came, and that terrified them."

Had our scientist kept his coral alive a little longer he might have seen strange things come to pass. He might have seen the "flowers" give birth to free-swimming, wormlike forms which sow their wild oats, so to speak, with the reckless temerity of the far-roving junior oyster, before coming to anchor upon a practicable rock, there to change shape, sacrifice length to breadth, bud forth calcareous spicules, and finally take on the true coralline mail.

Coral zoophytes have several methods of reproducing their kind. There are male polypi, female polypi, and polypi which combine both sexes. Some reproduce by budding, some by the production of eggs, which issue from the mouth; while in some the young leave the eggs before quitting the parent body. The great reef-builders do not produce eggs. Not all of them reproduce by any method. It would be impossible for the whole of them to do so. Only those favourably situated for the continuance of the species undertake the duty. Polypi are crowded upon polypi, myriad upon myriad, but every polyp of reef or island has its individual limy stem and home, and it is those which are most fortunately placed in point of position for the reception of food, those which can get their heads above the others, as it were, that carry into effect the mandate to be fruitful and multiply. These raise their heads above their stony casing, and from the fleshy body appears a series of buds. Each bud develops, if the conditions be favourable, and in turn puts forth other buds. Each bud is a potential polyp, which, without leaving home, will carry on the labour of the colony, secreting lime and extending the vast coral world of which it forms a part.

Photo by permission of the Queensland Government

Outer Barrier Reef of Australia

Through the clear water the submerged Beche-de-mer can be plainly seen.

Polypi, innumerable as the stars of the Milky Way, constitute the colony which builds an island or a reef. Life and death are continually in concurrent progress. A coral reef which rises from the floor of the ocean is, for the most part, the stony monument of innumerable lithotypes of other ages. It mounts on stepping stones of dead polypi. The soft body of the polyp perishes; its calcareous skeleton remains

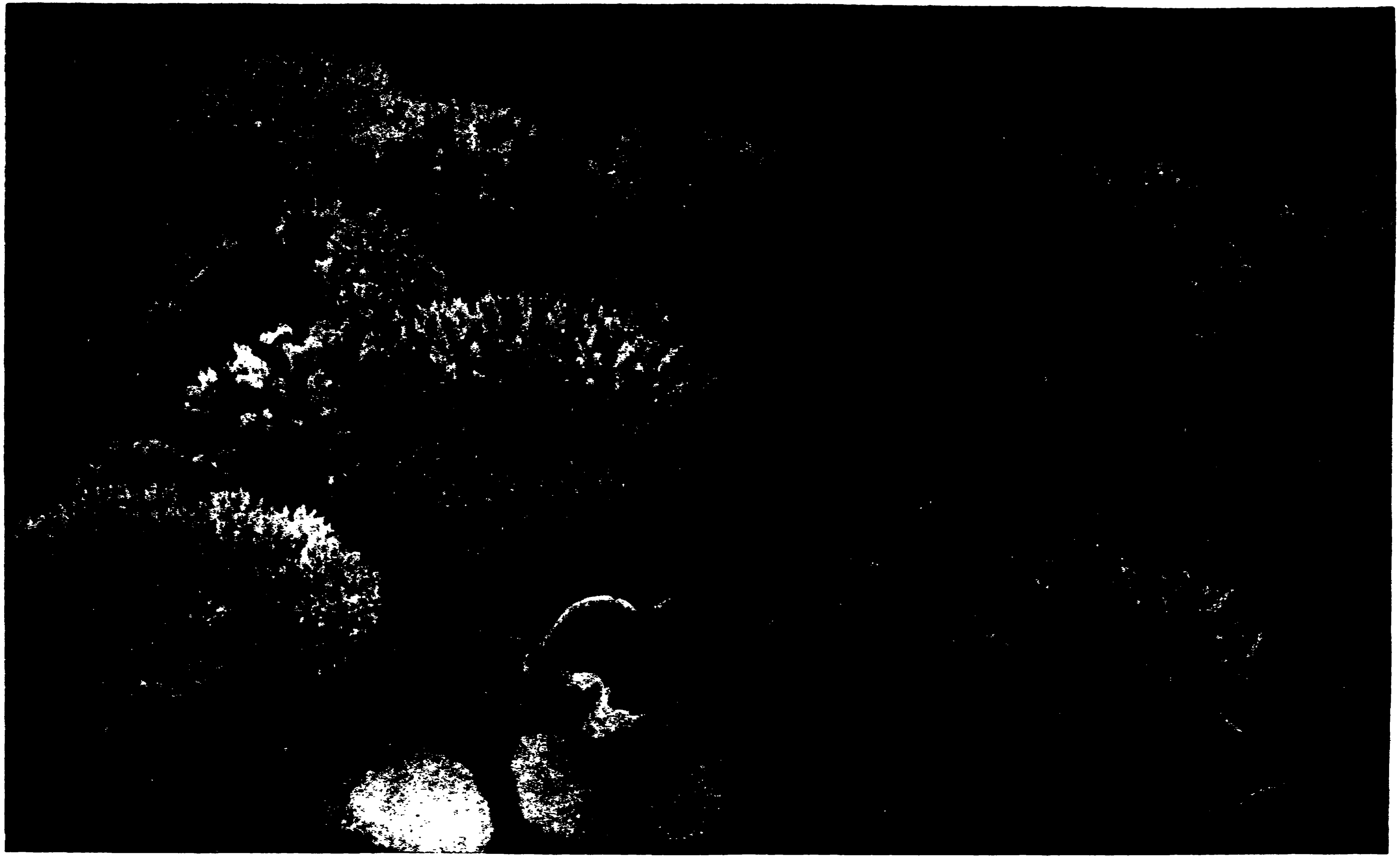


Photo by permission of the Queensland Government

Bleached Coral from the Great Barrier Reef

Australia is faced on the north-east by a coral reef extending over 1,250 miles. There are 3,000 miles of reef lying to the west of the Fiji Islands In some places coral reefs have been found to be 900 feet in thickness. Countless billions of billions of industrious builders must have perished to a foundation for succeeding zoophytes to build upon, and only the uppermost and outermost layers remain to carry on the work. When the open air is reached, life must be sought in other directions—laterally—from the sides of island or reef. For the polyp is a water-breathing animal, which drowns in air. Its food is in the sea, in minute algæ and microscopic organisms, which, by a magic metabolism, it converts into material for splendid halls that might fitly house old Neptune.

History of the earth is written in some of our coral reefs and islands. Darwin, who made few miscalculations, believed that coral structures are raised upon drowned volcanoes and sunken mountains. Their annular shape suggested extinct craters; the marvellous profusion of coral islands in the Pacific implied to his mind a general sinkage of the floor of that ocean. Later investigations to some extent support his theory, but not entirely. Some of the lagoons formed by the coral builders are far too vast to have been craters; some of the reefs are too mighty to crown mountains. Australia is faced on the north-east by a coral reef extending over 1,250 miles; 3,000 miles of reef lie to the west of the Fiji islands.

It is now ascertained that the living portions of coral structures do not extend, under ordinary conditions, to more than about 120 feet below the surface of the water, though one authority finds that where the submarine slope is moderate, the water clear, and breakers of no great size, reef corals may be traced to a depth of from 800 to 850 feet. Nevertheless, there are reefs 900 feet thick in solid coral. How are the conflicting evidences to be reconciled?

The polyp must begin at a slight distance below the surface. A few polypi become many polypi, all secreting their calcareous deposit and forming solid rock. As they build, the floor of the ocean slowly sinks. The floor goes down as the coral structure increases in height. During the process the sinkage is practically balanced by the uplifting of the dwellings of the zoophytes in successive ages. That would give us our reef of 900 feet in thickness.

The Living Polyps of Red Coral

(After Lacaze Duthiers)

But great depth is also secured in another way. In these steaming tropical waters animal life teems in unnumbered multitudes. Millions of little animals in calcareous shells are dying as others come into existence. The shells of the dead sink to the bottom, and gradually build up the bed of the ocean, build up as they built up when mountain ranges and the foundations of continents were being fashioned, from precisely the same materials, in ages too remote for calculation in terms of years. And on these foundations in the sea the polyp settles and colonises. Hence, the existence of coral reef or island does not of necessity in every instance imply a serious sinkage of ocean bed, the submersion of a mountain, or the drowning of a volcano.

The shape of atoll and island, of barrier reef and fringe reef is determined by natural causes, too many and too complicated to be considered in detail in a short article. These obscure little artisans, compared with whose operations the building of the Pyramids and the walls of Babylon was as child's

[illegible]

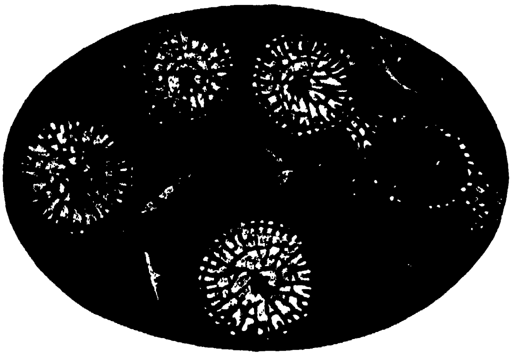
A Paradise of Beauty Beneath the Sea

Only the diver can glean an idea of the wonderful gardens of the sea, where many strange fish forms vie with the coral polypi and bright-hued anemone in brilliant coloration

play, have a definite scheme of life and work. Those succeed best which have access to the largest supplies of fresh food-charged water. Therefore those flourish which are on the outward side of the lagoon. Those upon the inner side, receiving smaller currents with scantier food supply, become weakly and die, so that building ceases upon the inner ring, and proceeds only on the outward. Tides, the eroding action of sea-water, and other causes, keep open the channels between the reefs and the mainland, and furnish those openings through which ships pass from peril to incomparable anchorage.

But of what avail to man is a coral structure built only beneath the sea?

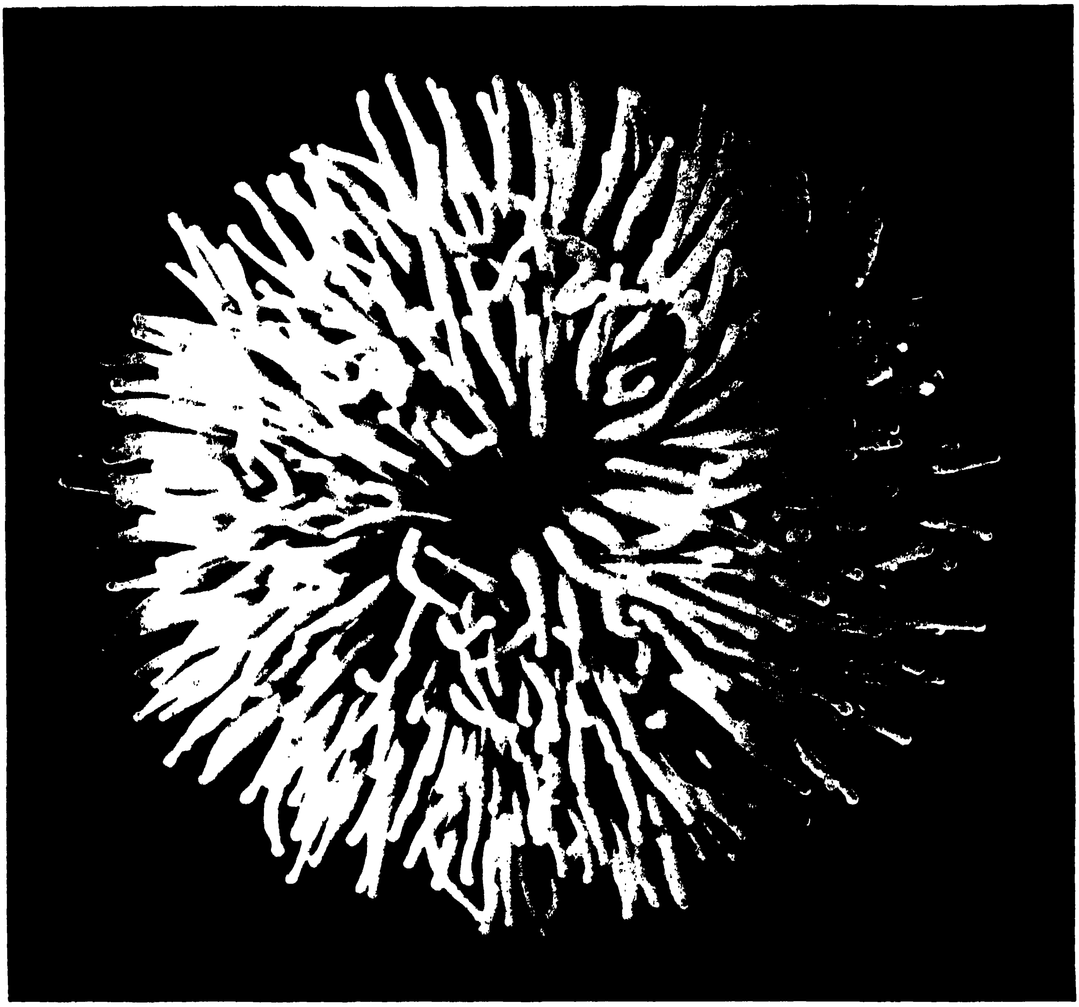
The coral cliffs climb upwards. A slow upheaval of land may and does thrust some of them above the surface of the water—in one instance the summit of a reef of coral has been forced, in this manner, three hundred feet into the air. But there is a steadier, less violent method by which the work of the unseen benefactor of man comes into notice. The wash and battering of the waves disintegrate the masses of coral, crack and fissure them, rip them from the mass, grind and powder them, throw them with giant force above the lower-lying strata. The detritus of successive erosions and grindings forms a sandy compost which washes into the interstices in the reef, and, solidifying, binds in place the masses which the sea has cast up. Slowly the height of the reef or atoll is increased, until presently dry land appears above the surface.


A Piece of Coral Limestone

Cut and polished, and placed under the microscope. Observe the corals in section

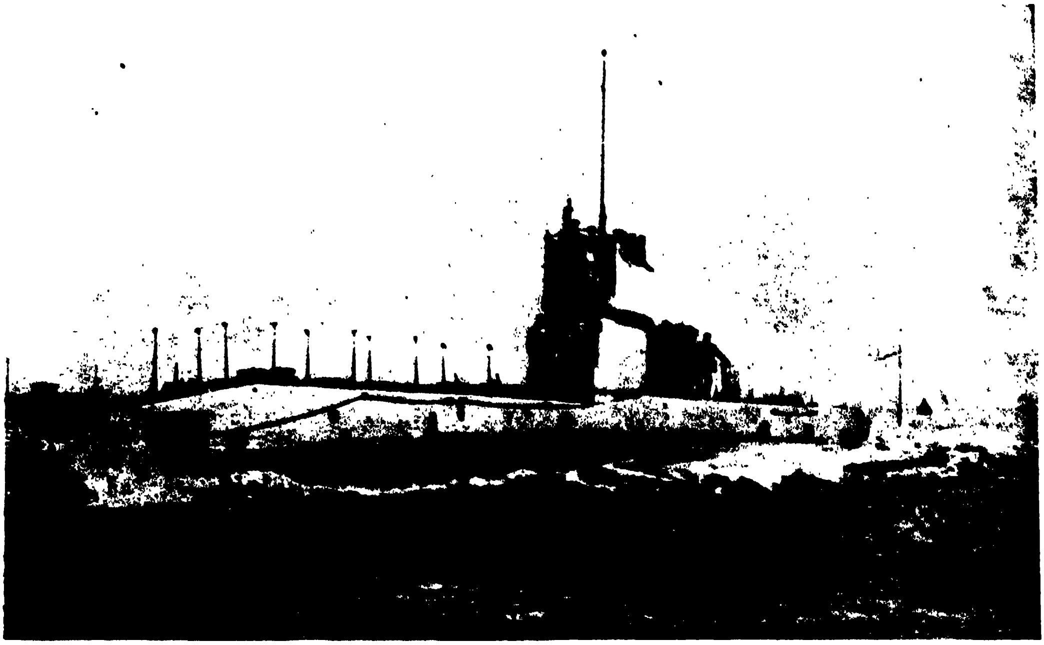
Thus the piling of rock upon rock continues, until at last the sea can no longer scale the monument which it has itself erected. The process of erosion continues so that the limy surface is ground into soil. Birds, weary with flight, alight upon the island and deposit seeds; other seeds are wind-borne, wave-carried; trees, uprooted by tropical tornadoes, come ashore upon propitious waves; a coco-nut from a distant island comes trundling to land. A garden not made with hands thus grows into being. Birds come to rest and to nest in the branches of the trees which spring up; lizards and other reptiles, with perhaps a mammal or so, arrive upon the flotsam and jetsam of successive storms, and at last comes man himself in his little canoe, to build him a hut in this ocean Eden, and call himself lord of all. Such, in brief, is the story which has been witnessed a thousand times, a story which adorns and crowns the life-toil of these unmighty workers of miracles in the deep.

With every prospect pleasing, a coral polyp would hardly declare that man alone is vile. He has a distinct grievance against certain abnormal types of fish which his habitation has called into being. The coral islands have their own peculiar types of marine life. Fish of the most extraordinary character frequent their sapphire waters. There we find the wonderful archer fish, which shoots its insect game with a jet of water, a course to which no polyp can object, whatever may be the emotions of the victim. But of the parrot-fishes an entirely different story might be told. These browse upon the polypi as a sheep browses upon herbage, nipping them off as they raise themselves from their sheaths, without a thought for the importance of coral animals in the scheme of things. The battle between these two forms of life must be of long standing. For the polyp has a sting in its tentacles, a sting hateful to the fish of sensitive snout. But the parrot-fishes have developed a horny "beak" upon which the polyp launches its sting in vain. And there are various Diodons, Chætodons, and file-fishes which prey upon the corals, each marvellously adapted in dental equipment for munching their limy prey. Besides these plagues to peace-loving zoophytes, the latter are vexed by a variety of marine worms and borers which tunnel the coral and invade their labyrinthine recesses, while crustaceans of many kinds batten also upon the animal flowerets. Life in the vicinity of the coral islands is expressed in marvellous colourings and the most bizarre of outlines; beauty, wonder, and strangeness characterise the surroundings of the master builders of the deep.



A Living Single Coral from the Pacific Ocean

The coral polyp, one of the master-builders of the world, may be likened to a sea-anemone, inferior in muscular organism, but immensely superior in defensive organisation



One of Britain's Wonderful Submarines

Our Mastery of the Depths

The Wonders of the Submarine

By G. HORACE DAVIS

JUST a fine line of foam and a small tube, less than six inches in diameter, whose progress is the cause of the disturbed water, and that is all we can see of the modern submarine when out on business. It can be truthfully said that these under-water fighters are one of the modern wonders of the world.

In the year 1918 Great Britain had eighty-five submarines, built or building, exclusive of those lost or removed from the service as obsolete. From the 150 tons of the original Holland boat, built in 1901, to the 1918 type of the "E" class of 900 tons displacement was a jump indeed. As the submarine has leaped upwards more than six times her original dimensions in a dozen years, and as in every succeeding class the size and power grows apace, and man's command of the depths becomes increasingly pronounced, it is almost safe to predict that in the near future the under-water fighting ship will replace the destroyer, and may, in years ahead, even become the mainstay of our fleet.

In speed and endurance, above and below the surface, there is the same wonderful advance. Twin-screws have replaced the single propeller of the earlier boats. Engines formerly burned the highly explosive gasoline; to-day a heavier and less volatile oil is used. Whereas the first boat was only able to cruise for 450 miles at nine knots speed, the present craft can make a trip of 4,000 miles.

The number of men carried has jumped

from a dozen to over thirty, and the hitting power from a single torpedo tube to the four and six tubes mounted in the 1918 type, which, in addition, carries one or more quick-firing guns on disappearing mountings.

Making Ready to Go Out

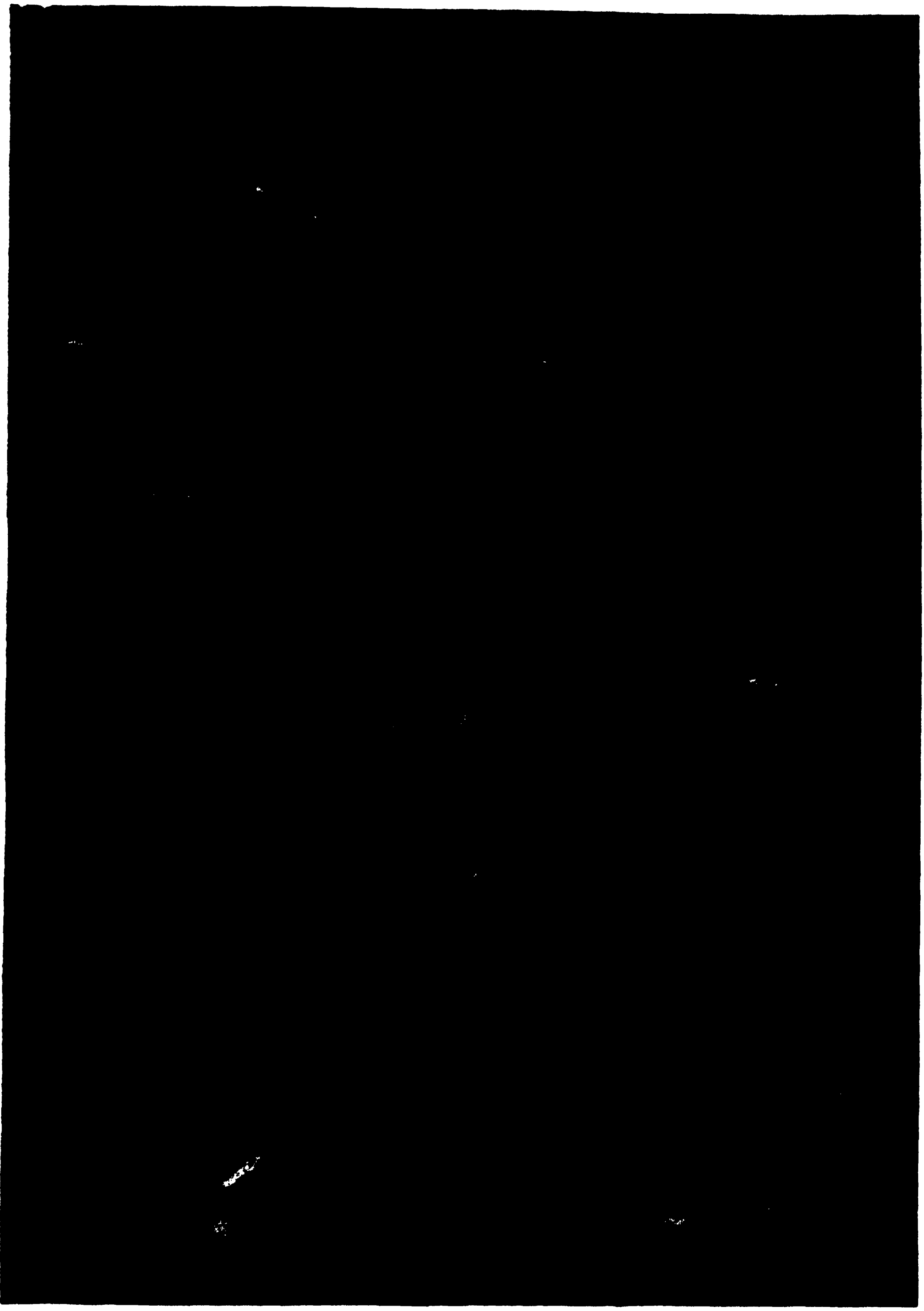
All the plating is covered with the regulation grey paint

To better understand the wonders of the submarine it is as well to come aboard one, in peace time, as she lies alongside Fort Blockhouse, the home of the Portsmouth Division, and accompany her to sea. Observe, as you step along the gangplank and reach her narrow deck, the robustness of her proportions.

Her crew, clad in thick woollen "sweaters," regulation blue trousers, and heavy sea-boots, are busy making ready to "go out." All the plating is covered with the regulation grey, and only her brass navigating fittings on her little bridge reflect the gleams of the sun. She is now in surface trim, so that her decks are well above the little waves. The torpedo hatch is shut, secured, and made watertight, her crew are aboard and at their stations; so, casting off from the pier of the Fort, she slowly "oils" out of the harbour down the deep channel past Southsea, and away towards the open sea. Now she finds the tide race, and the water begins to wash her under plating. Still proceeding, with her skipper on the bridge and the coxswain at the wheel, she steals away into the hurrying traffic of the Channel.

Go below, down a naked steel ladder, and find yourself in the steel maze of intricate mechanism that fills a submarine from end to end. It is a little steel-walled pen in which the thirty men who form the crew live in close companionship, officers and men drawn nearer together than in any other unit of our Navy. There is no room for comfort, and the space spared to the crew is grudgingly given; the officers' table folds away; the few electric cooking utensils pack in the smallest possible space, and there is no privacy for any man, no matter what his rating. Electric lamps, where required, illuminate the vessel, though the summer sun outside the thin plating of the hull is bathing the world around in light.

On every side are ranged big copper mains, each with its duty to perform. Forward are the great compressed-air cylinders, and neatly arranged in the bows,



Aeroplane versus Submarine

(Drawn by Norman Wilkinson)

The shadow, as of a great bird's wings upon the water, is cast by a bomb-dropping aeroplane, the commander of which has espied the loom of a submarine beneath the waves

amidships and aft, hang the Hall-Rees life-saving dresses. The latter are the life-boats of these under-water fighters; they consist simply of very light diving suits, which can be donned by the crew in a few minutes should the submarine dive too deep or meet with some other mishap that suddenly threatens the men with a watery doom.

Ready for Business

The submarine thunders ahead through the seas, clothing herself in a mantle of foaming water, until she reaches her rendezvous; then things begin to assume another phase, and the boat prepares to leave the world of fresh air for her place beneath the waves. All her movable gear—the wheel, the ventilation cowls, the compass, etc.—are removed and lowered inside the hull. The rails are turned down in one movement flush with the deck; the main ballast tanks are partly blown with compressed air, and the boat is sunk lower in the water until her decks are awash, and her conning-tower alone projects. The one hatch, hardly large enough to admit the body of a single man, alone remains open to the fresh sea air. She is now ready for business, and with her oil engines still thundering in conversation-preventing din, she makes away to where she hopes to meet her prey.

At last all come inside, the hatch is closed, the periscopes are pushed up to their full height, and the submarine prepares to dive.

The silence seems strange after the noise of the surface engines, as, with but a gentle hum, the electric motors which push her ahead below the seas take up their toil.

Only the legs of the lieutenant-commander can be seen; his head and body are hidden in the conning-tower. Behind and below him is the second-in-command, ready to receive the captain's orders and pass them on to the men concerned; the coxswain, clean shaven, sharp featured, and alert, is at the wheel controlling the horizontal rudders that work the vessel in her trips below—the vertical rudders, guided by the second coxswain, steer her to port and starboard. The leading torpedo-man is at the switchboard to attend to all the electrical devices that man has chained to his will to work this devil-ship; the torpedo-men are at the fully charged torpedo tubes. The engine staff, having seen that water and oil are shut off, are at the Kingston valves, vents and "blows" (or blow-off valves) of the main ballast.

Over all remains silence, broken alone by the hum of the motors. Everyone stands waiting, blind to the world without, waiting for the command of the one man who can see.

"Dive to fifteen feet." The order is quick and concise. In the next moment the bow has canted down ever so little, and the boat has like a shadow left the world of air. Guided by the steady hand of the first coxswain she has gone down 15 feet, keeping the periscopes a foot above the sea. In the far distance a big single ship, grey and sinister from truck to keel, is pitching a billowy mass of black haze from her two great funnels into the sky; her great 13·5 guns bristle from her upper works; in her are 900 men who, if it were real war, the submarine would doom.

The Torpedo Tubes

"Torpedo stations—make ready," comes the crisp order from above; the firing reservoirs of the tubes are charged instantly by compressed air; the caps covering the outside end of the tubes are raised by the "No. 2" of each tube, and water floods each chamber until, by spurting from a vent inside the boat, it tells the torpedo-men that all is clear for firing.

"Sixty feet!" from the captain, and from the coxswain a turn of the wheel sends us right down below *our* world into the watery depths. Cut off now from our kind, we blindly drive ahead, simply guided by the trained intelligence of the captain, whose eye is glued to the clock before him. Before we dived the captain took the bearings of his mighty foe, and, knowing our speed to an inch, he can calculate how far we are from our objective.

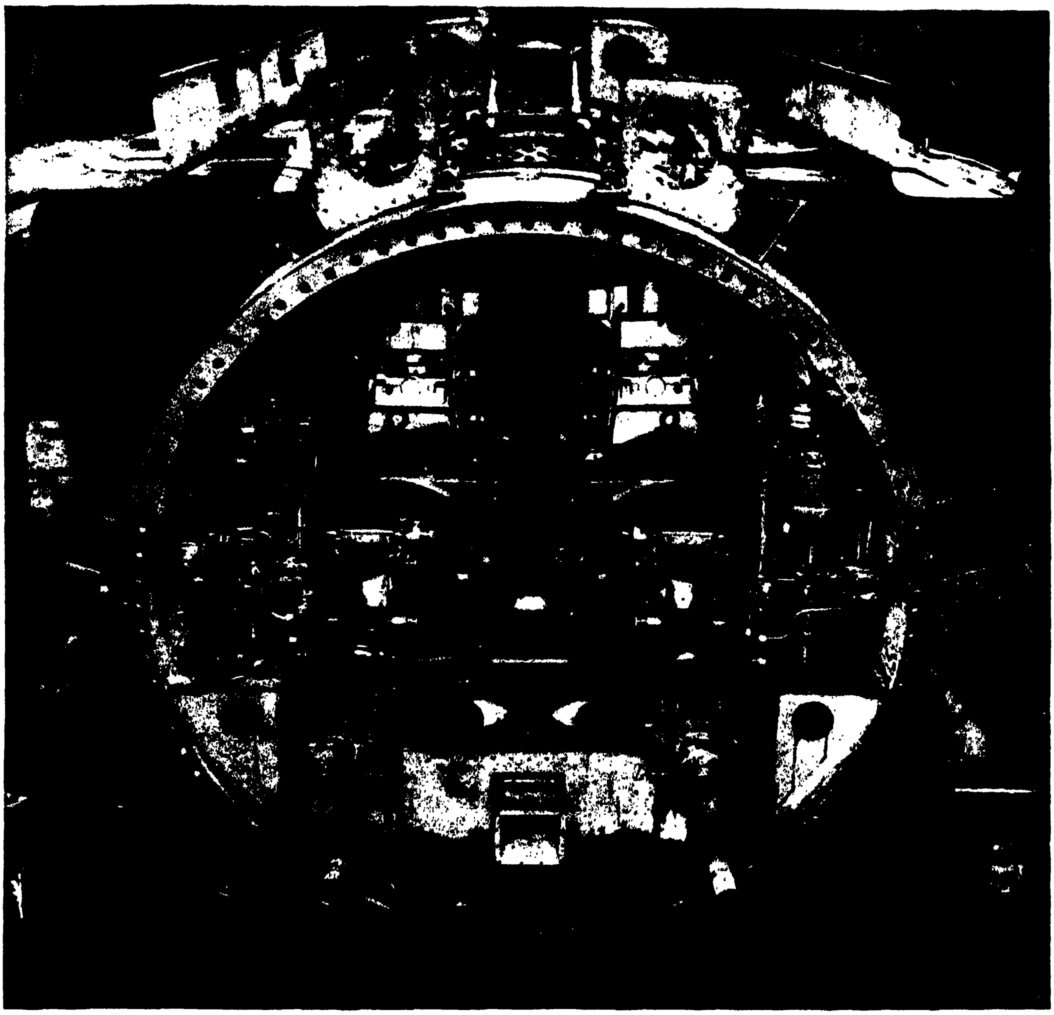


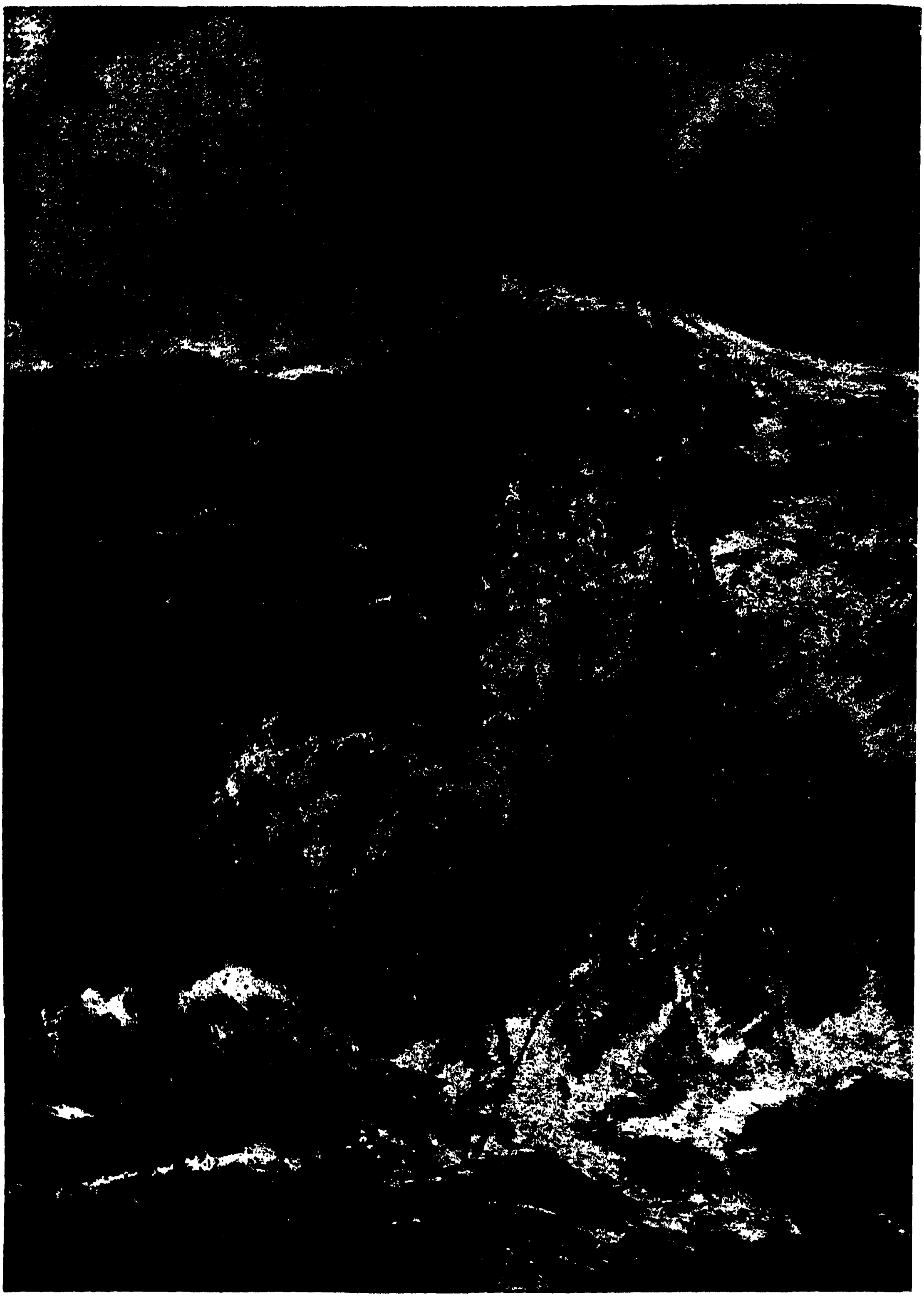
Photo by Techno.-Phot. Archiv

The Interior of the Norwegian Submersible "Kobben"

The interior of such a vessel is a steel maze of intricate mechanism that fills it from end to end

Already, in a deep-throated answer, the coxswain has repeated "Sixty feet, sir," and keeps her moving ahead until once more comes an order from the conning-tower, "Fifteen feet—starboard tube stand by." Once more our periscopes pop above the surface, and there, 1,000 yards away, is the great steel hull of the battleship, 600 feet of target, smashing through the seas.

The orders come quicker than ever, the men at the forward starboard tube are ready. "No. 1" (the senior torpedo-man at the tube) has jumped round to bang down the firing bell in case the electric circuit fails. The commander's finger crooks round one of the pistol triggers before him, very carefully he is taking accurate bearings, and, lastly, comes the single sharp command, "Fire." At the same moment he pulls the trigger, there is a heavy thud heard inside, a momentary alteration in the boat's trim, immediately



SENTINELS C

(Painted by

It is almost safe to predict that in the near future the under-water fighting ship will become the mai
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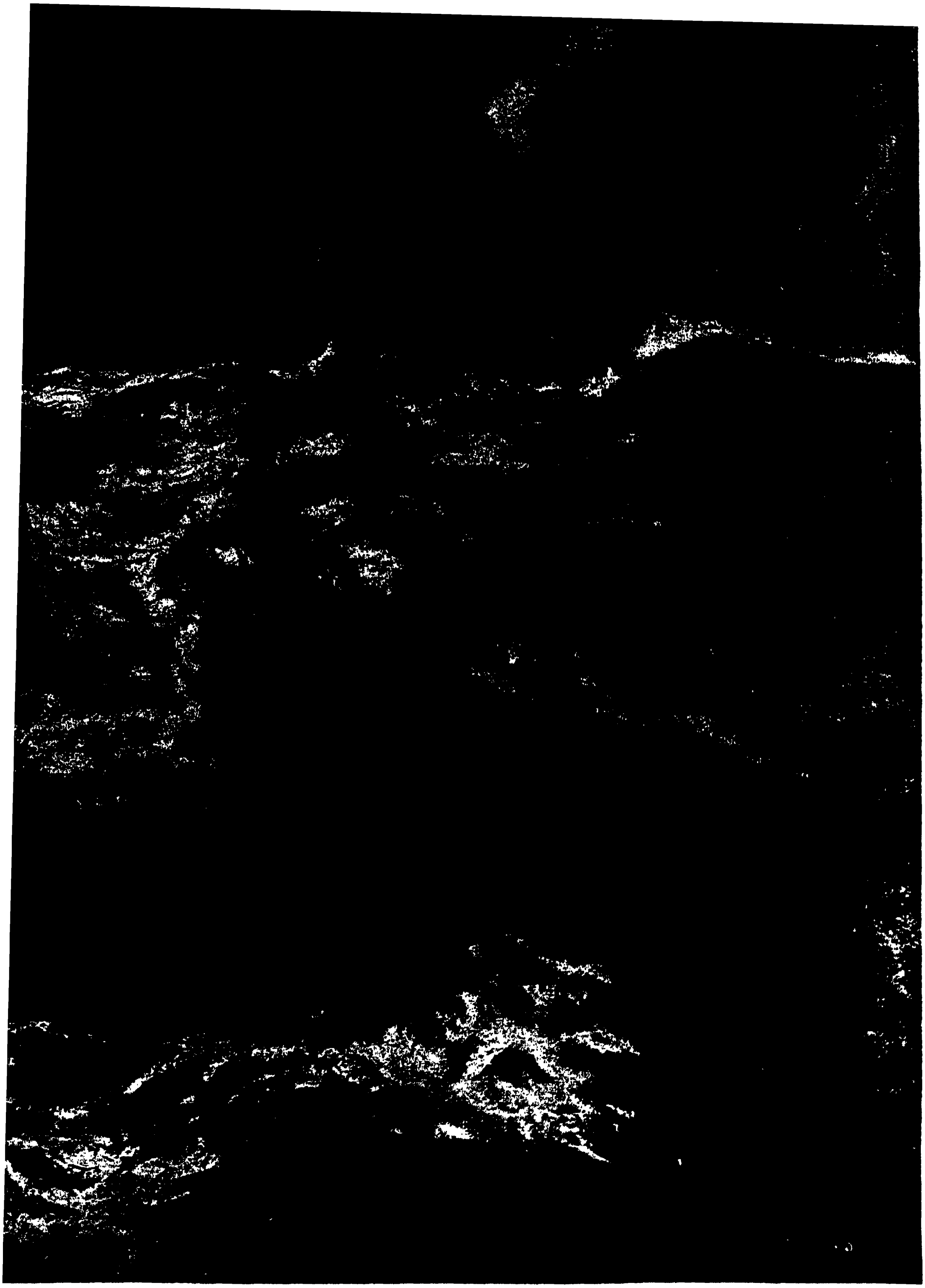


THE DEEP

J. W. Burgess)

stay of the fleet. Whereas the first boat was only able to cruise for 450 miles at 9 knots speed, the a trip of 4,000 miles

corrected by the ever alert coxswain, and at that same moment, at the rate of forty miles an hour, a torpedo, that in actual war would have over 200 lbs. of explosive in her war head, has picked up its depth and is careering away on its course accurately to its adjustment.

All the men stand still at their posts; not a word is spoken, there is no outward show of any excitement; it is but a part of the day's work, yet not one of them know but what there may be some miscalculation, some quick alteration in the battleship's course, and then, before they could think or act, a ram bow with 19,000 tons of steel behind it would be smashing them to oblivion. The officers' eyes are still glued to their periscopes, for "Dicky No. 2" (to use the crew's slang name for their second officer) is using the second periscope, and below the "blind" crew wait.

Suddenly something against the hull, just aft the big second funnel of the battleship, bursts into a flutter of white flame and pitches up a billow of smoke. Well enough those watching eyes know that it is the Holmes light, carried in the nose of the torpedo in place of explosive. There is an ejaculation from above, "Good shot—Right on her engine-room." The No. 1 of the bow starboard tube winks solemnly at No. 2. Across the water comes a blare of bugles and a rustle of movement, a big part of those 900 men who are working two million pounds' worth of the nation's money should by now, if it were the "real thing," be nearer death than they were five minutes ago. Meanwhile, quite unconcerned, we come up, and claim our prize. She launches a boat to capture the valuable torpedo, and we take her name.

Everything is easy, everything is brought to the acme of perfection. There is no bustle. The control of man over the depths has been achieved. We dive, and if necessary can stay below for twenty-four hours, and speed along unseen and undisturbed, cut off by another element than our own, surrounded by a strange finny world. For what great purpose have we striven in finally conquering these realms below the waves? Simply to perfect another device wherewith we can kill, and by killing keep inviolate our shores.

These mighty atoms of submarines that belong to us are handled by the finest trained men in the world.

Photo: Stephen Cribb

Submarine D1

Showing the wireless telegraph mast which keeps the submarine in touch with its parent fleet

Plant Vivisection

Some Remarkable Experiments which Suggest that Plants Feel Pain

By S. LEONARD BASTIN

Author of "Wonders of Plant Life"

THERE is no longer any doubt that plants can feel. It is not perhaps quite safe to say that they have nerves, yet the process by which sensations are conveyed about the plant is a good deal like that to be observed in animals. In both kingdoms the life basis—called protoplasm—appears to be the same, and whether in plant or animal it is this matter which is capable of receiving sensations. Running throughout the body of the animal is a highly specialised form of protoplasm—the nervous system. Living threads of the same vital matter, in a modified state, connect all parts of the typical plant.

In a general way the sensations of plants may not seem to be very striking. Leaves lean towards the light; they feel the stimulating rays, but the movement is comparatively slow. There are, however, certain plants which show signs of much more definite feeling. Of these, few are more remarkable than the Sensitive Plant (*Mimosa pudica*)—a species which seems to be "a bundle of nerves." This plant, which is now found in most of the warmer countries of the world, is most singular in its behaviour. At the approach of a man, or any heavy-footed animal, the foliage of the Sensitive Plant at once alters its position. The leaflets close together, and the stalks drop with a sudden jerk. Even a fly settling on the leaf will cause a very decided movement. Of what service these sudden changes of position may be is not definitely known, although it has been suggested that they are of use in frightening away animals which come to browse on the foliage. At night the Sensitive Plant closes its leaves, huddling them together as if it felt the cold chills of the hours of darkness.

Some very remarkable experiments have been carried out with the Sensitive Plant. Some of these almost suggest that the plant is capable of feeling pain. It has been indicated that anything in the way of a shock will induce the leaf of the Sensitive Plant to close up. If a leaf is smartly

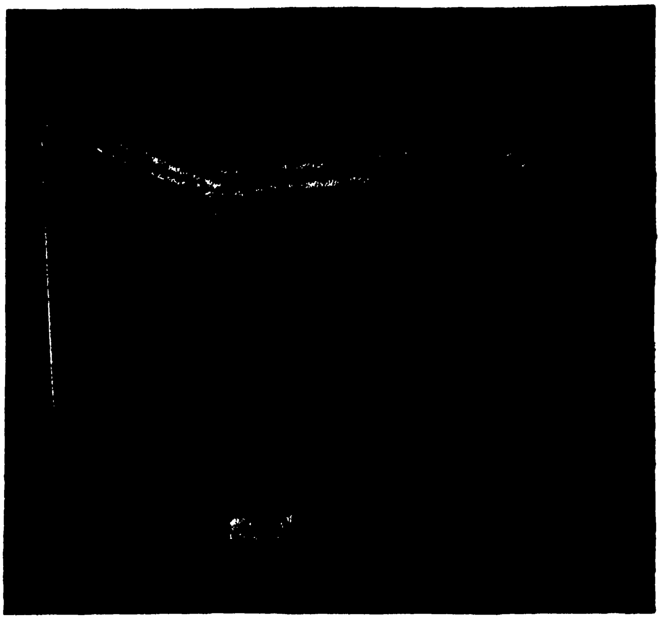
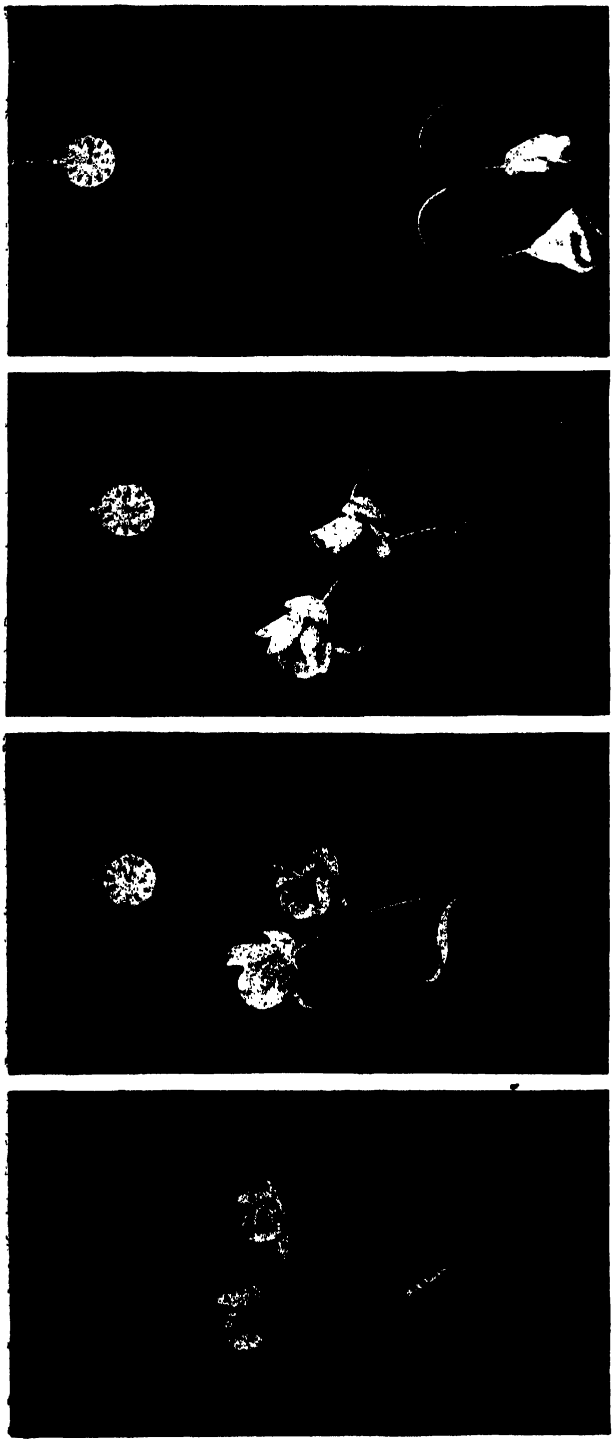


Photo: S. L. Bastin

Before an Operation

A Sensitive Plant under a glass screen absorbing chloroform from a saturated pad

tapped it will instantly show signs of feeling the blow, and the effect may be conveyed, by the agency of the protoplasm, of course, to some of the surrounding foliage. Now it is very remarkable that there is nothing which affects the Sensitive Plant so rapidly as anything which in an animal would cause pain. A very interesting test is that in which a lighted match is held for a moment under one of the leaves. Although the leaf be not scorched in any way the hot air causes it to shrink as if it had been hurt. Very much the same effect is evidenced when a tiny portion of the foliage is cut away; the plant behaves as would a wounded animal in similar circumstances. Strong electric shocks will also affect the Sensitive Plant acutely.



Photos: S. L. Bastin

Timing the Death of a Tulip

The tulips were injured at the lower parts of the stems so that their life blood flowed away. The watch times their death agony

Now it is a very singular thing that the sensations of plants are subject to much the same influences as are the nerves of animals. The Sensitive Plant may be over stimulated if the shocks are long continued. If the electric shocks are maintained over a long period, or the shaking of the plant is persisted in, the vital matter seems to become stunned and "tired." It is only after the plant has had a rest that it is able to respond in its usual manner to shock. In another way the Sensitive Plant strongly resembles an animal, in that it is greatly affected when submitted to the fumes of an anæsthetic. The administration of chloroform to this plant is a singular experiment. The plant is placed under a glass shade in such a way that the air is entirely excluded. A piece of cotton-wool is next saturated with chloroform, and this is then put under the

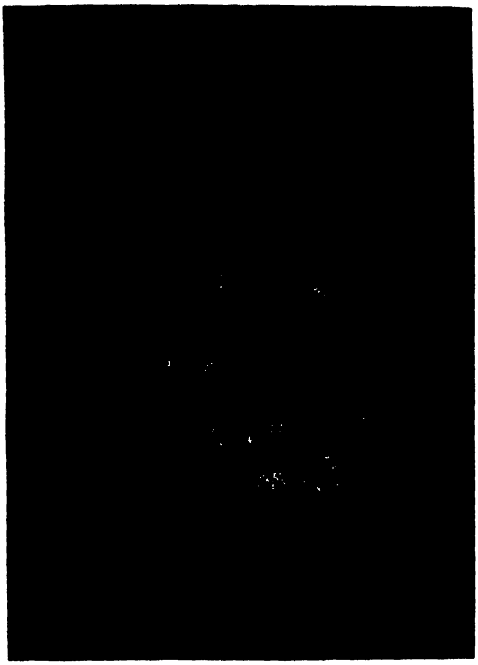


Photo: S. L. Bastin

Before an Electric Shock

A Sensitive Plant in good condition with an electric wire attached

shade with the specimen. After about an hour the foliage of the Sensitive Plant begins to droop, the leaflets close and the stalks fall down. Evidently the plant is drugged. In this state it gives no sign of being able to feel any shocks. There is no response to an electric current, whilst even the application of a lighted match will not in any way cause the plant to shrink. It is, in fact, completely under the spell of the anæsthetic, the same drug which renders animals quite unconscious of any pain.

In some ways even more singular than the Sensitive Plant is the Telegraph Plant (*Desmodium gyrans*), a species coming from India. The leaves of this plant are divided into three parts, a large central process and two smaller ones. Perhaps the latter are the most strange pieces of vegetation in the world. Without any very apparent stimulus they are always on the move, their tips describing a rough elliptical course. The movement is of a strange jerking nature, and has not inaptly been compared to that of the second hand of a watch. The rapidity of the movement depends a good deal upon the state of the atmosphere, and is quicker when the conditions are very warm. Under the influence of sunshine the jerks proceed at a very rapid rate, as many as sixty having been counted in a minute. In addition the large central leaflet keeps up a continuous movement, though this is very much slower. The actual course it takes seems to be an inclination first to the right and then to the left. As may be imagined a large example of the Telegraph Plant is most singular in appearance. In every part the foliage seems to be twitching, so that the leaflets are not in the same position for two seconds together. When night comes on the plant undergoes a marked change. It is extremely sensitive to cold, and (probably under the influence of the failing light) the foliage is huddled together to prevent loss of heat. In a few minutes it is difficult to believe that it is the same plant.

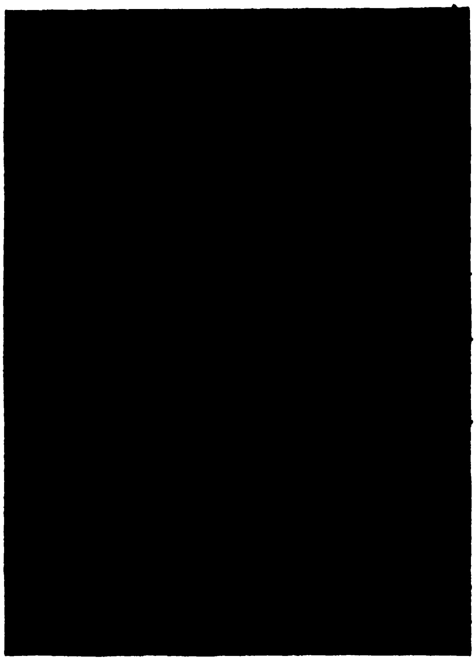


Photo: S. L. Bastin

After an Electric Shock

When shocks have been maintained over a long period the plant is stunned

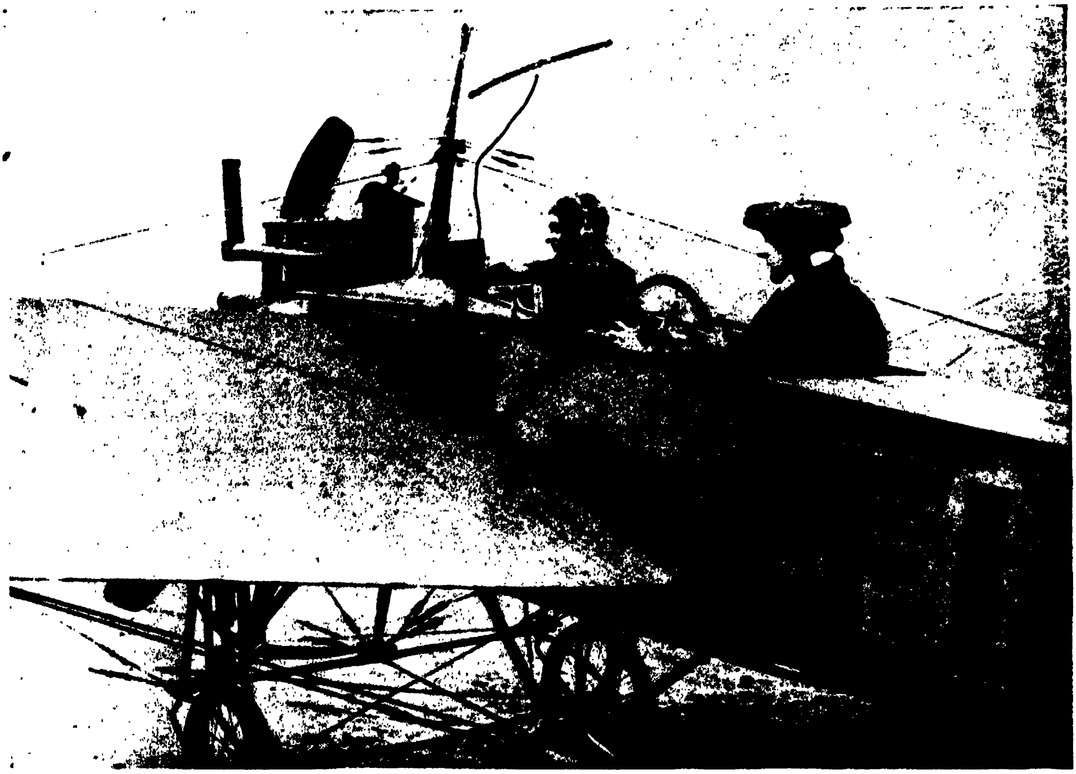


Photo. The London News.

Wireless Apparatus Fixed to a Luxurious Two-Seater

Touring by Air

Simpler than Motoring—The Rest-cure of the Future

By CLAUDE GRAHAME-WHITE

THE real delights of aeroplaning are even now unrealised, for the reason that there is a mountain of prejudice still to be removed. Accidents to airmen are sufficiently novel to be reported in detail, but narratives of safe flying are already apt to prove dull; and the result is that the ordinary man reads much about the former and practically nothing about the latter. He imagines, therefore, that five flights out of six end in disaster, whereas very many thousands of miles are now flown without mishap.

One fact needs special emphasis. Should his motor stop, when he is in flight, the pilot need not fall crashing to the earth. The engine, of course, is necessary for sustained flight; but even when robbed of its thrust the aeroplane is perfectly stable and under control. All that the pilot does is to replace, with the force of gravity, the momentum given him by his motor. That is to say, he tilts down his machine and begins a glide towards the ground. Descend he must, it is true, but his flight is under perfect control, and he is able to steer in any direction he pleases, so as to reach a suitable landing point.

The exhilaration of a cross-country flight, when compared, say, with the pleasure of

Brindejonc des Moulinais Fighting the Storm

(Drawn by G. Dutriac)

The picture shows this intrepid aviator, who once made a tour of 3,000 miles through Germany, Russia, Sweden, Holland and Denmark, speeding through a storm at over 130 miles per hour motoring, is infinitely greater. There is a joy in it, indeed, which is so deep that it can hardly be described in words. There is no vibration and no dust; there are no dangerous turns or cross-roads to be watched; and there is no speed limit. Added to this, there is the sheer thrill of flight and the invigoration of the air at a height, say, of 8,000 feet, acting as a pure, splendid tonic for those who have jaded nerves. Before long, in fact, we shall have Harley Street specialists recommending, quite seriously, an aeroplane tour as a cure for such highly-strung patients as are on the verge of a nervous breakdown.

The Aerial Tourist

There is, too, the magnificent bird's-eye view which an aerial tourist obtains of the land below, stretching away for mile after mile till it is shrouded in delicate mist, moving slowly, and appearing so far distant and remote, and yet seen in every tiny detail—roads like white ribbons, railways like tiny gleaming threads laid across the face of the country, rivers and lakes shining mirror-like, and buildings looking like the toy houses of a child.

Touring aeroplanes that are both scientific and air-worthy may now be obtained. There are, for instance, two-seated monoplanes—compared to the fast, runabout motor-car—and slower, weight-carrying biplanes, which may be likened to a comfortable touring car. These modern-type machines have neat, cosy, well-enclosed bodies with padded seats, and screens fitted to shield their occupants from the rush of wind when the craft is in flight; and they may be bought for sums that are a little more or a little less than a thousand pounds; it depends upon their horse-power and type.

The prospective owner who does not care about the idea of flying his own machine need not be deterred by lack of skill. He should have no difficulty, in future, in obtaining the services of an expert pilot, who will act as [illegible] chauffeur, for the world's airmen now number several thousand.

Even in England, and at the present time, there are enough aerodromes dotted about the country to permit of many aerial tours being made. The air-tourist, of course, like the motorist, needs an objective for the day's journey, and also somewhere to house his machine. France, as may be imagined, is far better off in respect of flying grounds than we, having more than a hundred. But already, in this country, we possess a reasonable number; and some, which have been established at the seaside, are very favourably situated for a visit during an aerial week-end. Thus, the man who owns an aeroplane, for instance, may make his head-quarters at the London Aerodrome, Hendon, and fly thence on Saturday to Eastbourne or Shoreham, where he will find landing stations and all conveniences. Enjoying trips along the coast, on Saturday evening and Sunday, he can fly back to town on Monday morning, both refreshed and delighted by his experiences in the air. Other and longer tours can also be arranged in peace time, so as to comprise visits to the many landing grounds inland.

Air Stations

As aerial touring grows, as it undoubtedly must, the number of our air stations needs to be increased greatly. The equipment of, say, an intermediate landing point—one such as will be placed along an important flying route—need not be elaborate. All that is required, in fact, is a suitable stretch of open ground with some sheds, a repair shop, a telephone, and one or two mechanics always in attendance. The establishment of such halts for the aerial tourist, which will correspond to garages for the motorist, must form one of the next developments of aviation.

The point I seek to make is this: aeroplanes, although regarded at the moment mainly as instruments of war, have really [illegible] possibilities as vehicles of pleasure.